FRONT COVER: A weapons carrier, glinting white in the Korean sun, has just been "kicked" from a C-119 "Flying Boxcar" and stands on end from the initial shock of the opening of its pilot chute. (December 1951)

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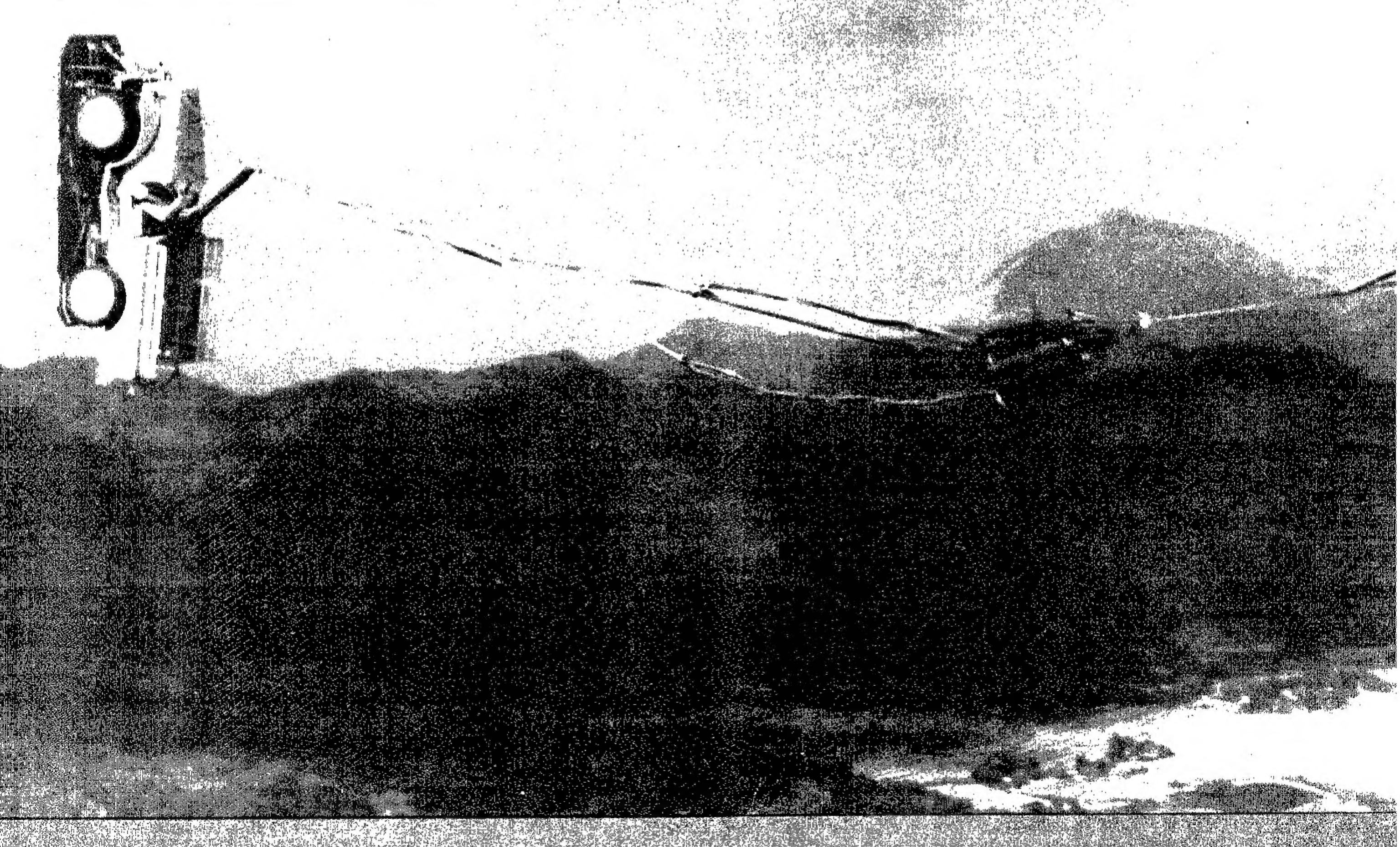
AIR FORCE JOURNAL of LOGISTICS

INNOVATION:
The Key to Successful Logistics



Agile Logistics: The Art of Logistics in the Twenty-First Century

Keith Shelton
David Davenport

Introduction

It is no secret that American Industry is undergoing radical changes. Corporations across America are attempting to come to grips with new business philosophies and practices.

The changes are not trivial. They move to the very core of the organizations' struggle to survive. Rosabeth Kanter, in *The Change Masters*, a book about changes in corporate America, argues that these changes constitute an absolute paradigm shift in thought and action. This shift has taken us to a "post-entrepreneurial" era of business. (9)

The post-entrepreneurial era bears little resemblance to the old, top-down, centrally controlled, bureaucratic institutions of previous years. Organizations that have made the change are leaner, quicker reacting organizations that have learned to "do more with less." (10:115) They have found ways to become more competitive with less structure. The bottom line is supported throughout the organizations.

Defense industries are no longer immune to downturns and business cycles. Prior to the collapse of the Soviet Union, American DOD-related industries could ignore the changes going on around them. Bolstered by 40 years of cold war and resulting government subsidies, American defense could survive any economic downturn. Washington often used DOD as a way of fueling the economy to reduce the extent of downturns. The practice of extreme government subsidy of the defense industry ended with the demise of the Soviet Union. DOD-related industries must become more productive and more competitive; they must, as Kanter describes it, "learn to dance."

Over the next seven years, the entire defense complex will be reformed and refashioned. The successful defense companies of the year 2000 will not look or act a lot like the defense companies of today.

As DOD-related industries change, the practice of logistics must undergo profound and substantive change. As the industry reforms and reshapes itself, logisticians must reform and reshape logistics activities. The question is not IF to change, but rather HOW to change. Now is the time to examine our future and develop the infrastructure required to accept and accommodate these changes. This is not intended to be a discussion of what new tasks logisticians will be performing, but rather how they will be performing those new tasks.

State of the Industry

The first part of the quest is to examine DOD literature for clues as to what stage our industry is coming to. One can hardly examine current defense journals without discovering articles concerning the reduction in defense budgets. Colorado's Representative Pat Schroeder, in *Defense Electronics*, talks about downsizing without cutting muscle. (3:23) Oklahoma's Representative Dave McCurdy states:

> There are going to be cuts, sooner or later. We need to prepare for that, and I think we need a rational plan of how we get there. (2:20)

Even the good news is often bad. A *Defense Electronics* article states: "The storm clouds should begin parting for defense contractors by the late 1990's." (13) For many in the defense/industrial base, waiting until the end of the decade for stabilization will be difficult.

It is clear that whatever happens, the defense/industrial base will become much smaller. We already see this happening. A simple plot of the total number of defense firms which have been acquired or merged as the industry restructures demonstrates this fact. John Harbison, an official of Booz-Allen & Hamilton, talks about an explosion in the numbers and size of acquisitions. (5) Dave McCurdy states:

> I think there will be a lot of hyphenated companies in the future, a lot of mergers and a lot of joint ventures, a lot of buy outs, a lot of downsizing. And I can't tell you who ought to go. I am a free marketeer to the extent that, whether it is going to be A, B, and C company or D, E, and F company, I believe it ought to be whoever is going to be the most competitive. (2:21)

Certainly we can see that the industrial base will be much different by the end of the decade. Again, Pat Schroeder remarks:

> One of the things that Reagan and Bush did was build up an industrial base that could not compete anywhere; it was totally dependent upon the federal trough. You take the trough away and they wither and die . . . . I would like to see them become a lot more entrepreneurial. (3:24)

By entrepreneurial, Schroeder means that the defense industry must take more responsibility in the creation and exploitation of market opportunities. The industrial base will become more "entrepreneurial" in several ways, but the result of entrepreneurship must be competitiveness. Every aspect of the organization must be competitive and must be a positive contributor to the company "bottom line."

Competition must come not only with other defense industries but with the nondefense sector as well. George Leopold writes in *Defense Weekly* that the Clinton Administration will push "dual-use technology." (11) Dual use means that defense research must be transferable to the private sector, and that defense contractors must compete with the private sector to get research and development money. Those companies which provide the best value for the dollar will receive the dollar. Rosabeth Kanter, writing her vision of "post-entrepreneurial" business, sums up what must happen to remain competitive:

> Lean, agile, post-entrepreneurial companies can stretch in three ways. They can *pool* resources with others, *ally*, to exploit opportunity, or *link* systems in a partnership. (10:119)

This pooling, allying, and linking will have profound effects on logistics.

Pooling, Allying, and Linking: Seeking Synergy

Pooling, allying, and linking, or PAL in Kanter's terms, is just a fancy way to say that competitiveness will come as a result of various forms of teaming. This teaming might be in the form of the special relationship between a company and its suppliers. It might take the form of consortia between related companies (Sematech, for instance). It might take the form of joint ventures with complementary companies. It might even take the form of joint ventures between competing companies.

This sort of vertical and horizontal teaming is quite common in Asia and Europe today. Only Americans hold on to an outdated "Lone Ranger" attitude. But clearly this attitude is changing. By the late 1980s, Ford Motor Company had more than 40 coalitions with outside companies; General Electric had more than 100 cooperative ventures. These cooperative ventures often involve competitors; for example, the IBM/Apple joint ventures now operating.

The crux of these special relationships is the blurring of boundaries between organizations. The tendency is to replace market relationships with organizational ones. (10:120) Listen to Rick Seymour of Hewlett-Packard as he talks about the relationships that developed with suppliers during the development of its 1.3-inch disk drive:

> . . . we had people living at AT&T, and they had people who lived with us. It became very hard to tell where the two teams began and ended. (1)

There are two goals of these special relationships. The first is to achieve synergies—the value that comes when the whole adds up to more than the sum of the parts. The argument goes something like this:

> If I do X very well and Y pretty well and you do X pretty well and Y very well, we ought to be able to work together. I will do X and you will do Y and the entire program will benefit.

The second goal of these special relationships is the reduction in product development time. The company which can develop products and bring them to market quicker than the competition will be able to develop competitive advantages. Shorter development cycles also help reduce costs. Those parts of the organization which cannot support these shorter cycles will be replaced with those who can.

Logistics in the Twenty-First Century

How does logistics fit into the "lean, agile, post-entrepreneurial" industry of the future? If the basic assumption is made that the task of the logistician will not be replaced in the future, how will those tasks be implemented? It is important to look at the way logisticians will work in the future.

Joint Ventures and Teaming

It is a mistake to discount the notion of joint ventures and virtual companies within the defense complex. Americans find it very difficult to function in joint ventures and tight teaming relationships among peers, and yet every author writing about next century business returns to some form of teaming as a necessity for competitiveness.

The routine formation of joint ventures, tight supplier relationships, competitive alliances, and virtual companies makes single company vertical and horizontal integration less attractive. Make-buy decisions are being made today concerning logistics products and services. If a technical manual can be produced cheaper by a lean, entrepreneurial military-qualified job-shop, project managers will select the cheaper option. The advent of Continuous Acquisition Life Cycle Support (CALS)* and readily accessible data means that competent job-shops can take over much of the logistics work that is kept inside today. By working away from the project in facilities not owned or financed by the parent company and working without the handicap of stifling overhead burdens, the job-shop can often provide services much more cheaply than in-house operations. In light of CALS, companies might not need large in-plant logistics operations—especially if that operation is both inefficient and costly.

As defense companies form joint ventures and virtual companies, redundant logistics capabilities add cost without adding value. Typically, today when a joint venture begins, we either duplicate the logistics effort or develop a leader/follower effort (one member of the joint venture works as lead logistics company with the other providing source and final data to the prime). This duplication is costly and, as program managers look for ways to save money, duplicate organizations will be targeted as excessive.

As CALS comes on-line and both partners of a joint venture have full access to technical data, it does not make sense to have duplicate organizations. The logistics organization which survives the joint venture is the one which is most efficient and flexible, and therefore most profitable.

Logistics and the Corpocratic Career

As joint ventures reduce duplicate logistics organizations and as technically compliant logistics job-shops are used, there is another phenomenon developing. It is what Kanter calls "the demise of the corpocratic career." (10:305) The definition of the corpocratic career is the "one person, one lifetime, one company career." It means that slowly progressing up the corporate ladder from individual contributor to supervisor, to manager, to officer, to director is becoming less and less possible. Because companies can opt for a "just-in-time" work force, there is less need for the traditional in-house work force.

As logistics services are contracted out to specialty houses and logistics job-shops, the typical logistics career with one large company is ending. Because larger in-house logistics operations cannot compete with leaner more agile logistics specialty companies, more and more logisticians will have to turn to the specialty houses for employment. Whole careers will not be spent with one company. It will be possible for the logistician of the future to have five or more careers with a dozen different companies.

As this switch from corpocratic careers continues, new skills become important. On the corpocratic ladder, corporate capital—knowing what the corporation wants and how to play the corporate games—is as important as the logistics skills one acquires. In the new order, flexibility will be the key. The ability to adapt to different company philosophies, the ability to acquire new skills rapidly, the ability to work in a diverse workplace, and the ability to change to meet new opportunities are the traits needed.

Developing the Infrastructure: Keys to Efficiency and Flexibility

How do we gain these skills? I believe that logisticians must develop an infrastructure which promotes the successful integration of three resources—technology, management structures, and work force—into a coordinated, interdependent system.

*Formerly Computer-Aided Acquisition and Logistics Support

Technology

Highly flexible logistics machinery is necessary for agile logistics. This "machinery" will take the form of fully integrated work stations which allow easy access to all available data (both engineering and logistics data). Concurrent engineering is difficult, if not impossible, without real-time access to all data. Logistics work stations must allow simulation and modeling and instant communication with customer, suppliers, and members of the engineering team.

None of this is really difficult. We have the capacity to create this technology now. The really difficult part about technology is its effective use after it is developed and available. Technology, the logistics work station, must link, not isolate, us to the rest of the organization. The technology must allow information to flow "seamlessly among manufacturing, engineering, marketing, purchasing, finance, inventory, sales and research departments." (6:8) And logisticians must learn to utilize this technology.

Management Structures

Turning our organizations—their structures and cultures—around takes top priority. Supervisors and managers must spend their time leading their people, not just managing them. Managers and supervisors must spend less time with capital packages and benefits packages and spend more time helping overcome barriers to efficiency. Managers and supervisors must actively work to CHANGE organizations into the lean, agile, post-entrepreneurial organizations of the future.

Andrall Pearson talks about the differences evident when comparing a large established manufacturing company to a young start-up high-tech company:

> In the first example, managers' efforts to improve performance were focused almost exclusively on the hard side—strategy, structure, and systems—but they didn't change the work environment. In the second company, managers worked hard and consistently to shape the organization's soft side to produce the kind of work environment that is needed in the new marketplace. (12:66)

Pearson points out that management must be committed to six interrelated goals if companies are to be turned around. We need to look at two of these goals: deciding what the company (or in this instance logistics) stands for and adopting organizational concepts that stimulate constant innovation.

Deciding What Our Logistics Organization Stands For

If our logistics organizations are to be competitive with other organizations and, if we are to compete with specialty houses and job-shops, all members of the organization must be imbued with the feeling that they are different—special. They need a vision of what their organization is today and will be tomorrow. Gary Hamel and C. K. Prahalad call this vision "strategic intent." (7:63) Strategic intent motivates and invigorates. It provides the goals competitive people strive for. In 1970 few people thought much about Komatsu. It was less than 35% as large as Caterpillar, did not extend much beyond Japan, and relied on one product line—small bulldozers. By 1985, Komatsu was a $2.8 billion company with a broad product line and pressuring Caterpillar in every market.

In 1970 few people thought much about Komatsu. But the people at Komatsu thought about Komatsu. Management put together an ambitious growth plan which was "out of all proportion to their resources and capabilities . . . they created an obsession with winning at all levels of the organization and then sustained that obsession over the 10- to 20-year quest for global leadership." (7:64) All the people at Komatsu knew that their goal was to "encircle Caterpillar."

Peter Drucker states that:

> For the organization to perform to a high standard, its members must believe that what it is doing is, in the last analysis, the one contribution to community and society on which all others depend. (4:98) The organization must be single-minded, or its members will become confused. They will follow their own specialty rather than apply it to the common task. They will each define "results" in terms of their own specialty and impose its values on the organization. Only a focused and common mission will hold the organization together and enable it to produce. (4:100)

If logistics organizations are to compete, they must see themselves in a very special way.

Adopting Organizational Concepts That Stimulate Constant Innovation

The Japanese have a saying that is roughly translated, "If you haven't been to my factory in five years, you haven't been to my factory." (8) Change is so pervasive for the Japanese that whole factories can radically change in five years. Are we doing things today the same way we did them five years ago, or does our organization reward innovation? What is our attitude toward failure? We must assure our people that innovating and failing is better than maintaining the status quo. Does it cost the same to produce a product today as it did five years ago, or have we found ways to continually reduce those costs? Our organizational structures need to tear down barriers between groups and must stop creating what Buddy Norred, the manager of Dallas Logistics Support Engineering at Texas Instruments, calls "silos of activity."

Work Force

Our need today is for a knowledgeable, creative, and flexible work force. In the manufacturing arena, constant innovation in the creation of products and services, as well as the improvement of manufacturing processes, provides competitive advantage. (6:10) It is no less true in logistics. Our infrastructure must produce knowledgeable, creative, flexible logisticians.

Knowledgeable Logisticians

Peter Drucker points out that in today's environment that "anyone with knowledge will have to acquire new knowledge every four or five years or become obsolete." (4:96) Obsolescence drives costs up and makes people less competitive. Training programs must be designed to keep people current and looking to the future.

Creative Logisticians

Lean, agile logisticians cannot be content with the current way of doing business. Lean, agile, post-entrepreneurial logistics will not rely on current practices, but will create new, more efficient, more competitive solutions to problems in a creative cycle that never ends.

Flexible Logisticians

The capability of maintaining an ever-changing knowledge base and creating new and more competitive logistics processes and services requires an exceptionally flexible work force. It demands a group of people who can function with less structure in a dynamic environment. It requires a work force that thrives

on change and can find order in chaos. Flexibility requires a constant process of learning and unlearning. We must give up hard-earned skills and habits of a lifetime; and, perhaps most difficult of all, we must be willing to give up old and treasured human relationships. It means abandoning what people have always considered "our community" or "family." (4:102)

Conclusion

It is no secret that American Industry is undergoing radical changes today. Corporations across America are attempting to come to grips with new business philosophies and practices. These changes will impact every aspect of the corporation. As defense budgets tighten, as competition increases, and as product life cycles lengthen and product development times shorten, logisticians will be forced to restructure their profession. We can see the future today. Now is the time to begin planning for that future and developing the infrastructure required to support that future.

References

1. Costlow, Terry. "How Design Team Made Kittyhawk Fly," *Electronic Times*, 20 July 1992, p. 55.
2. "DE Asks: An Interview With Dave McCurdy," *Defense Electronics*, July 1992, pp. 20-21.
3. "DE Asks: An Interview With Pat Schroeder," *Defense Electronics*, January 1993, pp. 23-24.
4. Drucker, Peter. "The New Society of Organizations," *Harvard Business Review*, September - October 1992, pp. 95-104.
5. Finnegan, Philip. "U.S. Girds for Wave of Mergers," *Defense Weekly*, 30 November - 6 December 1992, p. 1.
6. Goldman, Steve, and Priess, Kenneth, eds. *21st Century Manufacturing Enterprise Strategy: An Industry Led View*, Vol 2, Bethlehem: Lehigh University, 1991, pp. 8-10.
7. Hamel, Gary, and Prahalad, C. K., "Strategic Intent," *Harvard Business Review*, May - June 1989, pp. 63-76.
8. Imai, Masaki. *Kaisen: The Key To Japan's Competitive Success*, New York: McGraw-Hill, 1986, p. 65.
9. Kanter, Rosabeth Moss. *The Change Masters: Innovation & Entrepreneurship in the American Corporation*, New York: Simon & Schuster, 1983.
10. Kanter, *When Giants Learn To Dance*, New York: Simon & Schuster, 1989.
11. Leopold, George. "Industry Awaits Clinton's Action on Dual-Use Technology," *Defense Weekly*, 30 November - 6 December 1992, p. 8.
12. Pearson, Andrall. "Corporate Redemption and The Seven Deadly Sins," *Harvard Business Review*, May - June 1992, pp. 65-75.
13. "There's Light at the End of Budget-Cutting Tunnel, EIA Predicts," *Defense Electronics*, January 1993, p. 14.

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Most Significant Article Award

The Editorial Advisory Board has selected "Planning Reception, Beddown, and Support of Contingency Operations" by Captain Wayne C. Foote as the most significant article in the Summer 1993 issue of the *Air Force Journal of Logistics.*

Opportunities Offered by the Future Extinction of Middle Management

Steven R. Irvine

Introduction

There is an international drive to work smarter, not harder, as companies strive to become more competitive. One of the consequences has been the restructuring of the corporate entity. This has resulted in the severe reduction or, in some cases, the elimination of middle management.

The role of middle management has always been one of a communication filter between executives and first-line supervisors. They have been responsible for translating strategic plans into tactical activities. The summarization of day-to-day activities into executive reporting has also been performed at this level.

In the future, there will not be adequate resources to perform the type and volume of work currently being done by middle management. Today, effectiveness is measured several ways. All the activities performed need to be evaluated against these measures to determine which should be eliminated. Even after undertaking the restructuring of the job of middle management, resources will still not be adequate for future demand.

Tools to multiply management effectiveness must be employed. The successful company of the future will be driven by fully integrated information technology. Databases will be in place to support day-to-day operations of the company. Expert systems will be in place to act as executive information systems and operations information systems. The primary function of information technology will be to act as the middle management buffer between the two diverse needs of the corporation.

The technology exists to transition to this future state. Many obstacles need to be addressed today to ensure safe arrival to this goal. Data security and corporate ethics and crime will play an increasing role. Accuracy, currency, and effectiveness will face new standards as corporations strive for Six Sigma quality. Bureaucracy and politics will govern control of databases. These must be addressed to ensure we improve the bottom line, doing less with less.

Today's Organization

In a recent address, William Raduchel, SUN Microsystems, spoke of the corporation of the future being loosely coupled and highly aligned. This organization would have a span of control of roughly 10 to 1.[1] This has significant implications to the existence of middle management. Table 1 shows the impact of the number of levels of an organization with a given span of control. There is no room for middle management.

This is not only true in perfectly balanced organizations, but also in less-balanced organizations. There can be no room for middle management in our organizations in the future. Yet, there will still be a need for this layer of management. Or will there?

So what of these managers of managers? What has their role been? Do we really need this role anymore? Their traditional role has been one of decomposition and synthesis. They take the strategic plans and decompose them to the tactical approaches used in day-to-day activities at the line level. In the opposite direction, they synthesize the day-to-day accomplishments to an understandable level to executive management. To quote Tom Peters:

> What we are against is wrong-headed analysis, analysis that is too complex to be useful and too unwieldly to be flexible, analysis that strives to be precise (especially at the wrong time) about the inherently unknowable. . . . The management techniques of the last twenty-five years have actually been necessary.[2]

But management has been necessary by virtue of the fact that much of the wrong (or unnecessary) tasks were being performed. For their role to effectively be carried out, areas of procurement,

		Span of Control						
		9	10	11	12	13	14	15
L	1	1	1	1	1	1	1	1
e	2	10	11	12	13	14	15	16
v	3	91	111	133	157	183	211	241
e	4	820	1,111	1,464	1,885	2,380	2,955	3,616
l	5	7,381	11,111	16,105	22,621	30,941	41,471	54,241
s	6	66,430	111,111	177,156	271,453	402,234	579,195	813,616

Table 1.

manufacturing, marketing, and logistics must be well-balanced within the organization. Let's now examine the advantages and disadvantages present in the current organization. During this discussion, there may appear to be much "management bashing." This is not the intent. Management has functioned in the past. The situations I point out are those which must be changed in the future to ensure an organization's survival. The status quo will not endure. As indicated previously, middle management has acted as an information processor.

Please recall the childhood game we all played. Several individuals would line up in a row and whisper a message to the next individual. As an adult, I believe the real purpose of the game was to remind us of what not to do when we grow up. The message somehow changed from one end of the chain to the other. Being a purist, I choose to believe that no one intentionally changed the message.

The same phenomenon exists in our corporate structure. The messages are being passed up and down the organization. There is little or no interaction allowed between levels. Also, due to a lack of trust and a host of other reasons, the message may be distorted (intentionally?).[3] The extent of this distortion may be from minor to criminal. Certain corporations are traditionally characterized by an ethical culture, while others appear to be unethical regardless of top management personnel.[4] The factors affecting these distortions can be divided into two categories, internal and external.

Internal

(1) The role that top management plays in unethical practices and illegal behavior.

(2) The role of excessive pressures exerted by top management on middle management.

(3) The extent to which corporations are characterized by unethical or ethical cultures.

(4) The degree to which the nature of the corporate organization precludes employee cooperation with government in dealing with corporate violations.

External

(1) The role of competitive practices.

(2) The influence of generally negative attitudes produced by government regulations.[5]

When decisions are made on bad information, one cannot expect to maximize profit.

Tomorrow's Organization

What are the advantages and disadvantages of the organization of the future? The organization of the future is also wrought with challenges. The foremost problem will be one of culture shock. The top management will be forced to deal with a younger generation than it has in the past. This gap will be problematic as the old-agers, educated in an environment void of personal computers and technology, are faced with the technology and fast-paced issues and opportunities brought by new-agers. Can the organization effectively exist?

Information technology will provide many of the solutions to help executives deal with the new culture. This will be primarily made possible by (1) extensive communications networks, (2) accessible distributive databases, and (3) enhanced human interface workstations.[6]

This can most appropriately be considered automating of managers. The technology for automating middle management exists today; however, it is not in widespread use. The vehicles for this approach will be in the form of expert systems, decision support systems, and a new generation of software to translate the strategic plans to the tactical and operational needs of the firm. This will provide feedback and control of executive information systems within reach of all team members of the management structure. The implications of these systems are to multiply the effectiveness of the remaining layers of the organization. To this end, several guidelines must be followed:

(1) Do not make managers do things; make managers want to do things.

(2) Do not let managers become obsolete; develop capabilities to meet new needs.

(3) Do not hope it happens; define commitments.

(4) Do not try to ride off in all directions; make alignment of executive information systems a total commitment.

(5) Do not let the "loner" limit output; give the job to team players.

(6) Do not make decisions; make decision makers.

(7) Be a full-time manager of time; get it done through others.

(8) Do not stand still; be a manager on the move.[7]

The automated middle managers in the future will perform much of the same role as their human counterparts. They will be (to the extent of the automation involved) free of the transmission errors and distortion of their past human counterparts. The intelligence to be captured will consist of several key elements: data capture, data storage, data transmission, data reformatting, data display, and decision making. Figure 1 shows how the data flow between executive management and first-line supervision could occur in a theoretical organization. But with the reduced cycle time and accuracy of data comes another challenge. Security of data will become increasingly important. Data must be available to all who need access and only to those who need access. Data must be made available at a lower level of the organization than it ever has before. Executive management must be trusting enough to allow data to sink through the organization levels to the most appropriate level. This will be an interactive process as the appropriate level is determined. Rest assured, it is lower than what it is today.

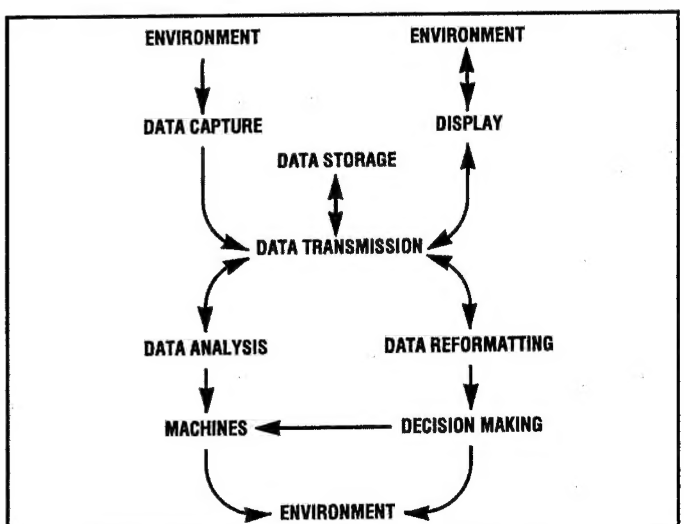

Figure 1. Possible Data Flow Between Executive Management and First-Line Supervision.[8]

(Continued on page 11)

A Neural Network Approach to the Inventory Range Problem

Captain Steven B. Reynolds, USAF
Wayne B. Faulkner
Robert E. Smith

Introduction

A fundamental problem for supply systems is that of correctly predicting what items should be stocked on the shelf in anticipation of future customer demands. This problem is often referred to as the "range" of stock. If an item is included in the range of stock and future demands do not occur, the "dead stock" represents a nonproductive expenditure of capital and warehousing costs, in addition to potential costs associated with shelf-life expirations and obsolescence. On the other hand, if an item *is not* stocked and a subsequent demand occurs, customer service is sacrificed. Depending upon the nature of the requirement, the shortage costs associated with the inability to fill the customer demand from the shelf may be high.

The US Air Force has not been immune to these inventory range problems. In fact, a great deal of work has been done in recent years studying Air Force inventory range policies for expendable (consumable) supply items. The rules currently used by the Air Force for deciding whether or not to include expendable items in the range of stock are based on a combination of heuristics and analytical models. Specifically, items are stocked if one or more of the following conditions are satisfied:

(1) There are 12 or more customer demands within a one-year period.

(2) A single high priority (weapon system grounding) demand occurs.

(3) The item is identified by the user as a repetitive, shop-use requirement.

(4) The cost to stock (based on an economic order quantity (EOQ) demand level) is less than the cost to not stock (based on expected shortage costs). (12)

The intent of these range criteria is to stock items which have a high likelihood of incurring future demands, thus maximizing customer service (and weapon system availability). Recent analyses of the current range model performance indicated that only about 50% to 60% of the items stocked are subsequently demanded within a one-year period. (14) Additionally, the studies have shown that many stockouts occur for items which are not identified for stockage by the current range rules. Because of these findings, the Air Force has continued efforts to find improved heuristics for determining what range of items to stock. (13,15) In this paper, we analyze and report the performance resulting from the application of a three-layer backpropagation neural network model to the previously described inventory range problem.

Background

Simply put, a neural network is a massively interconnected set of simple, neuron-like computational units. In this paper, we use the most common neural network configuration, three layers of sigmoidal units. A simple three-layer backpropagation network is illustrated in Figure 1. The numbers of nodes (circles) at the three layers shown in the figure are purely for purposes of explanation. In fact, the number of nodes on each layer is a function of the specific problem being analyzed. As indicated in the illustration, information is propagated forward through the network. The nodes on each layer are connected to all nodes on immediately succeeding layers. The network does not contain any backward connections nor are there any connections between nonadjacent layers. The input nodes are essentially just portals through which raw or preprocessed data is input to the network. The hidden nodes function as feature extractors. The network training process explained in subsequent paragraphs essentially reorients the input data into more meaningful groups which are then used to map the network inputs to appropriate outputs.

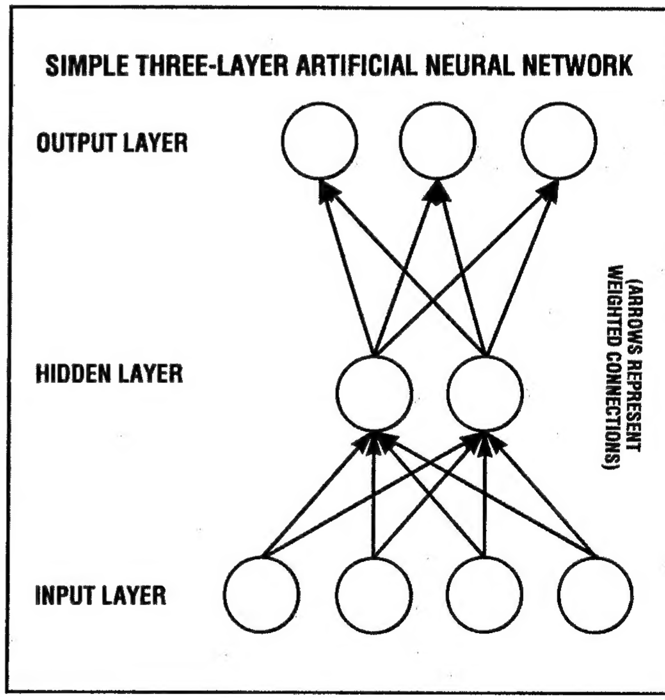

Figure 1.

Each network connection has an associated weight, and each hidden and output node in the network has a mathematical threshold value assigned. When the summed value of all incoming weighted signals exceeds the threshold value of a node, the neuron is activated and a signal is sent to all succeeding connected nodes. The "learning" that takes place in neural networks is represented by the adjustment of the connection weights. There are a variety of learning (weight changing)

procedures for determining when and how the weights are changed. A training algorithm which has been found to be very useful in addressing problems of complex pattern recognition and performing nontrivial mapping functions is called backpropagation. (16) In fact, it was the development of the backpropagation algorithm that is generally credited with the recent resurgence of interest in the study of artificial neural networks. (1,6) Thorough discussions of the backpropagation algorithm and standard network structures are available in the current literature. (4,10)

Unlike traditional computer programs which perform sequential instructions, neural networks simultaneously explore many competing hypotheses. The network's computational elements are "trained" in a way which maps significant states of a system into more compact internal representations. (20) Lippmann states that a two-layer network can form any half-plane decision region. (8) Simply stated, this means that the connecting weights can be adjusted in a two-layer network so that any linearly separable decision can be correctly mapped. Most problems of interest, however, are not linearly separable. An earlier mathematical theorem advanced by Kolmogorov indicates that, as long as the elements of an input item lie between 0 and 1, a three-layer network can perfectly map any real item of dimension *n* to any other real item of dimension *m*. (3) Application of Kolmogorov's theorem to artificial neural networks suggests that a three-layer network can be used to form any unbounded convex region in space. (8) Lippmann goes on to state that "a four-layer network can generate arbitrarily complex decision regions." (8) Rumelhart, Hinton, and Williams also confirm that multilayered networks can always relate inputs to appropriate outputs. (16)

In addition to excellent mapping abilities, neural networks have been shown to have good generalization characteristics. (22) Freeman and Skapura state:

> The power of an ANS [artificial neural system] approach lies not necessarily in the elegance of the particular solution, but rather in the generality of the network to find its own solution to particular problems, given only examples of the desired behavior. (4)

Wasserman and Schwartz reported, for example, that a network trained to recognize printed letters was able to correctly identify previously unseen characters even when they were 40% corrupted by noise. (19)

Another distinct strength of neural networks is that they can abstract the ideal from imperfect training sets. Freeman and Skapura claim that:

> The inherent ability to deal with noisy or obscured patterns is a significant advantage of an ANS approach over a traditional algorithmic solution. (4)

Wasserman and Schwartz report the results of a study where a network that was trained with corrupted letters was still able to correctly identify perfectly formed letters. (19) The authors also stated that the findings of a study involving the categorization of words in sentence structures indicated that neural network internal representations are quite efficient even when trained with imperfect data. (19)

There are numerous interesting examples which indicate that neural network backpropagation techniques are often useful in predicting the outcome of future events based on known variables. Maren, Harston, and Pap report that neural networks are used by the Department of Energy to forecast energy needs through time-related markets. The authors also summarize work by others that indicates neural networks have performed better than regression techniques and Box-Jenkins models in forecasting studies. (9)

Keyes outlines some novel uses of neural networks to forecast outcomes. One example detailed how a commodity trader used data from a cross-section of 25 commodities to determine whether the New York Stock Exchange would rise or fall on a given day. A similar forecasting application was implemented at the Security Pacific Bank in California to conduct risk analyses. A backpropagation methodology was used with a 27-variable input item to determine whether to accept or reject individual loan applications. The network was trained using data from 6,000 prior loans which resulted in a very successful loan-underwriting system. (7)

Another interesting application of neural networks in forecasting was the prediction of upcoming plays in a football game. A three-layer backpropagation model used offensive and defensive play-calling factors, along with knowledge of opponent talent and game conditions to correctly predict 75% of the offensive plays run by the opposing team. (5) More recently, Bylinsky reported successful applications of neural networks in such diverse areas as the detection of credit card fraud, pension fund investments, and horse-race betting. In fact, the author states that the results of a recent trade journal survey indicated that 85% of the US, European, and Japanese engineers questioned believe that neural networks are the hottest topic in computer technology today. (2)

Shewhart sees the increased use of neural networks in organizations as an important factor in successfully competing in today's more competitive marketplace. He specifically lists several areas where conventional approaches have fallen short and neural networks can be used to aid in making complex decisions. Interestingly, his first suggested area for the application of neural networks is forecasting "the demand for spares based upon historical trends." (17) Indeed, the positive results of previous applications indicate neural network models may be useful in predicting which items are likely to incur future customer demands in inventory systems.

Methodology and Data Description

Previous Air Force studies of inventory range models indicated that perhaps the best predictor of future demand is past demand. (13,14,15) Additionally, in a four-year study of quarterly demand patterns for expendable items, Smith found that 30% of all items with no demands in a year subsequently experienced drastic increases in demand. (18) Based on those findings, we hypothesized that multiple periods of demand history were probably needed to correctly predict future demand.

To conduct the study, we considered a random sample of stocked and nonstocked expendable items. We used actual USAF parts consumption data from England AFB, Louisiana, to conduct the investigation. The data was obtained from the Air Force Stock Control Data Bank at the Air Force Logistics Management Agency, Gunter Annex, Alabama. Historical consumption data for 299 expendable supply items in the federal stock group 47 (hoses, tubes, and duct assemblies) were drawn from historical records over a 4 1/2-year period. The number of customer demands during 6-month periods was concatenated into a single record for the current (April through September, 1991) and 8 past periods for all 299 items.

One of the goals of this study was to determine the minimum number of demand periods needed to achieve a useful backpropagation model. In the analysis, the number of historical

demand periods was varied to determine the minimum number of periods required to enable a three-layer backpropagation model to develop a "good" prediction of future demand for a given item. Therefore, the smallest input file used was a single predictor (first past period demand), and each subsequent model formulation incorporated the next previous demand period as an additional predictor.

Analysis

We conducted the analysis in two phases. In phase one, the performance of the current USAF range model was quantified. In the second phase, three-layer backpropagation neural network models were developed, tested, and compared to the current Air Force range model.

Current Model Performance

The first step in the analysis was to quantify the performance of the current USAF range model. The performance was measured by looking at the four possible outcomes of stocking an item: items may be stocked and demanded, stocked but not demanded, demanded but not stocked, or not stocked and not demanded. These outcomes are illustrated by the performance grid in Table 1:

	Items Demanded in Current Period	Items Not Demanded in Current Period
Items Stocked	Success	Failure
Items Not Stocked	Failure	Success

Table 1. Four Outcomes Used as Performance Measurements.

To quantify the performance of the current system, the demands in the current period were considered along with the demand level which resulted from the current USAF range model. Actual demand and demand level quantities (greater than 1) were not considered. That is, if an item had demand greater than 0 and a demand level greater than 0, it satisfied the conditions of the upper left-hand block of Table 1. The magnitude of the quantities was irrelevant since our only concern in this study is range, and the size of the demand level for a given item is a stock *depth* issue. The performance of the current system is shown in Table 2:

	Items Demanded in Current Period	Items Not Demanded in Current Period
Items Stocked	88	84
Items Not Stocked	2	25

Stockage Accuracy = .57

Table 2. Current USAF Range Model Performance.

Note that the data indicating the stockage and subsequent demand characteristics for the first 100 of our 299 sample items previously mentioned were held out for training the backpropagation models described in the next section. The remaining 199 items were reserved for testing the performance of the neural network models. Therefore, only the performance of those 199 items shown in Table 2 are appropriate for stockage performance comparisons.

Analysis of the data in Table 2 shows clearly that the current range model is very liberal. In all, 172 of the possible 199 items were included in the range of stock. Although 88 of the 90 items which were subsequently demanded in the target period were in stock, 84 items which were not demanded were also needlessly stocked. For purposes of future comparison, the stockage accuracy of the system is defined as:

$$\frac{\text{Stocked and Demanded + Not Stocked and Not Demanded}}{\text{Total Number of Items Considered for Stockage}}$$

Implicit in this definition is the assumption that it is equally undesirable to stock unneeded items as it is to not stock needed items. Using this definition, the stockage accuracy of the current system is approximately 57% (113/199).

Backpropagation Model Development

With the current USAF range model performance quantified, the first of eight backpropagation models was developed using the PlaNet System. (11) The first model used only one period of demand (and thus, one input) to predict the target demand. As explained earlier, information pertaining to the first 100 items was used to train the network. The network was structured with five hidden nodes and one output node. During training, the network output values were controlled in a way which allowed the outputs to take on only values which were near 0 and 1. The network weights were trained such that the sample items which had subsequent demands produced output values close to 1. Items which did not have future customer demands were trained to produce outputs nearly equal to 0.

The network was trained via backpropagation for 1,000 cycles. A cycle is defined as one complete pass through the training set. The network converged to a 32% error rate. The error rate represents the mean squared error across the output nodes for all training patterns. Next, the same data was input to a network with 10 hidden nodes. Since, after 1,000 training cycles, the resulting error was virtually identical to that of the smaller network, we concluded that a five-hidden-node network was sufficient for the analysis.

After the network was trained, the remaining 199 items were presented, and the outputs and targets for each item were written to a file. The output values for each item were rounded to the nearest integer. The rounded values were then used as the stockage decision. A value equal to 1 indicated an item should be included in the range of stock, while a value of 0 implied the item should not be stocked. The stockage accuracy performance resulting for this procedure is shown in Table 3:

	Items Demanded in Current Period	Items Not Demanded in Current Period
Items Stocked	51	33
Items Not Stocked	39	76

Stockage Accuracy = .64

Table 3. One-Period Backpropagation Model Performance.

The 64% stockage accuracy of the model exceeded the current USAF range model. This is an impressive result in view of the fact that the three-layer network model used only a single period of demand history while the current USAF model uses

seven variables and nine parameters. Although the network model results would provide 37 fewer off-the-shelf fills of subsequently demanded items, it compensates by stocking 51 fewer items not subsequently demanded.

Slightly better performance resulted (stockage accuracy of 65%) when two past periods of demand were used to develop a backpropagation model. The outcome is detailed in Table 4:

	Items Demanded in Current Period	Items Not Demanded in Current Period
Items Stocked	69	49
Items Not Stocked	21	60

Stockage Accuracy = .65

Table 4. Two-Period Backpropagation Model Performance.

The network model using three periods of previous demand yielded slightly worse results than the two-period model; however, like the one- and two-period models, it was still better than the current USAF model. The stockage accuracy was approximately 62%. Table 5 shows the resulting performance grid:

	Items Demanded in Current Period	Items Not Demanded in Current Period
Items Stocked	48	34
Items Not Stocked	42	75

Stockage Accuracy = .62

Table 5. Three-Period Backpropagation Model Performance.

Subsequent three-layer network models using four, five, six, seven, and eight periods of previous demand were also evaluated in the same manner. The bar graph in Figure 2 summarizes the stockage accuracy of the current USAF model and all eight backpropagation neural network models.

As shown in Figure 2, all eight of the backpropagation network models provided very similar stockage accuracy rates, ranging from 59% to 66%. Further, note that, in terms of stockage accuracy, all eight backpropagation models provided better results than the current USAF range model. Although the best stockage accuracy resulted from a network model using seven periods of past demand, the results from the one- and two-period models were arguably the most impressive.

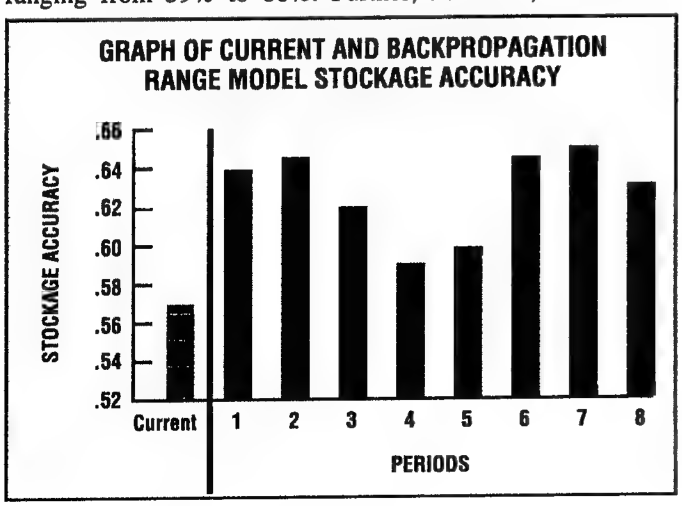

Figure 2.

Two important considerations in selecting a useful range model are the amount of data required to make a decision and the amount of time required to obtain the needed data. As indicated earlier, the current range model requires the input of multiple (16) data elements and results in a stockage accuracy of 57%. Although the stockage accuracy is somewhat low, one clear advantage of the current model is that all of the data required by the model can be obtained within one demand period. Therefore, the range decision can be made more quickly after limited demand experience is available.

Surprisingly, this analysis showed that, with equally limited demand experience, a three-layer backpropagation model resulted in even better predictions. A second advantageous feature of the backpropagation model was that demand history was the only data needed (versus 16 input elements required by the current model). **Thus, better stockage accuracy results were achieved, with less data, within the same relatively short period of time.** In addition, even greater stockage accuracy resulted when a backpropagation-based range model was used and the range decision was delayed until two 6-month periods of demand history were available.

Summary and Conclusion

Although this study only examines a small group of items, the results presented in this paper show clearly that a backpropagation neural network model is a useful tool in predicting what items are likely to experience future demands based on past demands. The backpropagation models outperform the current USAF range model in terms of stockage accuracy, while using demand data from the same relatively short time periods and requiring far fewer data input elements. This result indicates that, at least in terms of economics, the neural network approach to the inventory range model produces very favorable results. Combining a neural network approach with a second range heuristic which is sensitive to mission impact indicators may well offer an alternative to the current Air Force inventory range methodology.

References

1. Burke, Laura Ignizio. "Introduction to Artificial Neural Systems for Pattern Recognition," *Computers in Operations Research*, Vol 18, No 2, 1991, pp. 211-220.
2. Bylinsky, Gene. "Computers That Learn by Doing," *Fortune*, September 1993, pp. 96-102.
3. Caudill, Maureen. "Neural Networks Primer, Part III," *AI Expert*, June 1988, pp. 53-59.
4. Freeman, James A., and Skapura, David M. *Neural Networks; Algorithms, Applications, and Programming Techniques*, Reading MA: Addison-Wesley, 1991, p. 6.
5. Hillman, David. "Knowledge Systems Based on Cascading Neural Nets," *AI Expert*, December 1991.
6. Jones, William P., and Hoskins, Josiah. "Back-Propagation: A Generalized Delta Learning Rule," *Byte*, October 1987, pp. 155-162.
7. Keyes, Jessica. "Getting Caught in a Neural Network," *AI Expert*, July 1990.
8. Lippmann, Richard P. "An Introduction to Computing with Neural Nets," *IEEE ASSP Magazine*, April 1987, pp. 4-22.
9. Maren, Alianna J.; Harston, Craig T.; and Pap, Robert M. *Handbook of Neural Computing Applications*, San Diego CA: Academic Press, 1990.
10. McClelland, James, and Rumelhart, David. *Parallel Distributed Processing*, Vols 1 and 2, Cambridge MA: MIT Press, 1986.

11. Miyata, Yoshiro. *A User's Guide to PlaNet, Version 5.6: A Tool for Construction, Running, and Looking into a PDP Network*, University of Colorado, 1991.
12. Moller, Randy; Blazer, Douglas; Faulkner, Wayne B.; and Ham, Martha P. "Stockage Policy Course Material for Supply Officers," *Air Force Logistics Management Center Final Report LS850515*, January 1985.
13. Reynolds, Steven B.; Geasey, Michael; Orr, George; and Faulkner, Wayne B. "New Activation Spares Support Level Procedures," *Air Force Logistics Management Center Final Report LS860305*, May 1988.
14. Reynolds, Steven B.; Faulkner, Wayne B.; and Rau, Gregory "Analysis of EOQ Hybrid Range Model Performance," *Air Force Logistics Management Center Final Report LS881278*, September 1989.
15. Reynolds, Steven B.; McKenna, Peter H.; Johnston, Rosemary; and Faulkner, Wayne B. "Analysis of EOQ Range Criteria," *Air Force Logistics Management Center Final Report LS902006*, July 1990.
16. Rumelhart, D. E.; Hinton, G. E.; and Williams, R. J. "Learning Internal Representations by Error Propagation," in *Parallel Distributed Processing*, Vol I: *Foundations*, eds. James L. McClelland and David E. Rumelhart, Cambridge MA: MIT Press, 1986, pp. 318-362.
17. Shewhart, Mark. "Neural Networks: A New Tool for Planning and Analysis." *Logistics Spectrum*, Vol 24, Issue 2, Summer 1990.
18. Smith, Palmer W. "Item Migration Concepts and Patterns—Helping to Overcome Uncertainty in Demand." USAF briefing presented at the 1988 USAF Logistics Capability Symposium, Colorado Springs CO, 1988.
19. Wasserman, Philip D., and Schwartz, Tom. "Neural Networks, Part 2: What are They Used For and Why is Everybody So Interested in Them Now?" *IEEE Expert* (Spring), 1988, pp. 10-15.
20. Works, G. A. "Neural Network Basics," in *Neural Networks: Current Applications*, ed. P. G. J. Lisboa, New York NY: Chapman and Hill, 1992, pp. 35-48.
21. Zigoris, Dean M. "Performance Evaluation of the Back-Propagation Algorithm for Character Recognition," Master of Engineering Thesis, Department of Electrical Engineering, University of Louisville, December 1989, photocopied.
22. Zurada, Jacek M. *Artificial Neural Systems*, St. Paul MN: West Publishing Company, 1992.

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(Continued from page 6)

Conclusion

The extinction of middle management is not certain. The extinction of organizations that do not place middle management at least on the endangered species list is certain. Little effort has been made toward this end. To many it may not appear to be a real possibility. Planning must start today. The road to the elimination of middle management will not be an easy one. As we make radical changes to processes and management of resources, our organization must also change radically.

Notes

[1] Raduchel, W. J. "Managing Change in the Information Age," *ORSA/TIMS*, San Francisco, November 1992.

[2] Peters, T. J., and Waterman, R. H., Jr. *In Search of Excellence*, Warner, 1982, pp. 31-32.

[3] Read, W. H. *Some Factors Affecting the Accuracy of Upward Communication at Middle Management Levels in Industrial Organizations*, University of Michigan, 1959, pp. 62-65.

[4] Clinard, M. B. *Corporate Ethics and Crime, The Role of Middle Management*, Sage, 1983, pp. 22-23.

[5] Ibid.

[6] Morton, S., M.S. *The Corporation of the 1990s*, Oxford University Press, 1991, p. 31.

[7] Marvin, P. *Multiplying Management Effectiveness*, American Management Association, 1971, p. ix.

[8] Moss-Jones, J. *Automating Managers*, Pinter, 1990, p. 21.

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Defense Logistics Agency Support: A New Tool for Oversight and Control

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Introduction

The last few years have ushered in a new era in logistical support. The consolidations and reorganizations throughout the Department of Defense (DOD) have literally changed the face of logistics for each Military Service and the Defense Logistics Agency (DLA). Responsibilities of the Services have declined and those of DLA have increased. For example, the wholesale storage depots of the Services were transferred to DLA on 16 March 1992, and the transfer of most of the Services' consumable items are being assigned to DLA.

The Agency is now assuming a greater role in logistics support. Its annual budget of $12 billion is used to purchase parts, food, fuel, clothing, and medical supplies in support of all Services. Out of the four million parts managed by the Agency, approximately 1.2 million are linked to Service weapon systems. More importantly, fully 80% of all Service requisitions—from routine to mission capable (MICAP)—are placed with DLA. And, of that 80%, 85% are requisitions for weapon system-coded parts.

With this greater volume and increased emphasis on effective DLA support, primarily for consumable items, both DLA and the Services need mechanisms to assure continuous, effective parts support. To that end, DLA recently completed development of a prototype system which promises to provide much-needed visibility and diagnostic capabilities. As the program head for development of the DLA Automated Weapon Support System (DAWSS), I can accurately describe the evolution and ultimate fielding of this unique system. This article first presents some background information on the need for a new weapon support system within DLA and the Services, and then describes the development of DAWSS, including its basic intent, structure, and limitations. Next, because of the unique system structure, the paper explains the input options and output products separately. Finally, it discusses future directions and uses of DAWSS, and concludes that this system will provide managers with a better grasp of problem areas.

Background

Recently, the DLA Weapons Support Branch conducted a general review of available management tools and found that, basically, DLA management information fell into two categories: item and aggregate. *Item information* included all of that specific, detailed data necessary to manage individual stock numbers. *Aggregate information* was usually Inventory Control Point (ICP) (i.e., the entire DLA Supply Center) or Agency-wide measures. However, there was no intermediate information necessary to link the item and the aggregate.

But was there a need to establish the link? Intuitively, the answer was yes. For example, if an ICP or Agency measure is falling, where do we start fixing the problem? If the Air Force complains about parts support, how can DLA define the problem in a way that can be corrected? These questions are not new; however, three events defined the need for DAWSS and its structure:

Event 1: To begin investigating possible performance measures, we started with an examination of the backorders for five key Air Force systems. Basically, we conducted a manual count of backorders for Fiscal Year (FY) 1991, grouping them within Federal Supply Class (FSC). The results were striking. All five systems shared common problem FSCs. In fact, only ten FSCs accounted for 65% to 73% of all DLA backorders for those systems (Figure 1). In other words, if DLA focused management attention on those ten FSCs, the DLA support to those five Air Force systems would substantially improve.

Event 2: After analyzing the backorder data, we examined the supply availability (roughly equivalent to stockage

FEDERAL SUPPLY CLASS	WEAPON SYSTEMS (% of Backorders)				
	B-52	C-135	F-111	C-5	F-15
5305 - Screws	4.8	5.9	4.8	5.6	12.0
5306 - Bolts	5.6	6.3	4.3	7.8	4.7
5310 - Nuts and Washers	15.6	12.2	14.9	14.5	12.4
5320 - Rivets	18.7	11.0	14.4	17.8	13.7
5330 - Packing/Gaskets	6.1	7.6	8.7	8.4	7.5
5340 - Miscellaneous Hardware	1.6	2.0	3.1	3.0	3.4
5935 - Electrical Connectors	2.1	3.3	3.9	3.3	3.3
6135 - Nonrechargeable Batteries	8.8	4.7	7.4	0.7	6.5
6240 - Electrical Lamps	6.6	8.9	4.1	4.8	4.9
9150 - Oils and Greases	3.4	3.3	4.0	3.1	3.0
TOTAL:	73.3	65.2	69.6	69.0	71.4

Figure 1. Percent of Weapon System Backorders for Individual FSC Contribution.

effectiveness) measures for possible similarities. We performed a linear regression for each ICP using the amount of demand supported below 50% availability as the independent variable and the total supply availability rate as the dependent variable. The results indicated that each percentage of demand an ICP supported above 50% increased the overall ICP supply availability one full percentage point. More importantly, only five FSCs accounted for between 45% and 64% of the poorly supported requisitions (Figure 2).

Event 3: The previous events indicated that a relatively small number of FSCs accounted for a disproportionate number of problems. We next focused our attention on a specific FSC to find out if this was the appropriate level for management attention. Because the Army was complaining about FSC 6220 (Electrical Vehicular Lights, Fixtures), we chose this class as a logical starting point. One company (XYZ) was the dominant vendor within this FSC. Basically, supply availability for the FSC was 92% without XYZ and 69% with XYZ. Since the company had insufficient capacity, XYZ would shift attention to address support problems. In other words, XYZ would shift workers to produce more headlights. DLA would "get well" in headlights. However, other stock numbers produced by XYZ would fall behind in production. As a result, one stock number would get well as others got sick. Only by looking at the FSC as a whole could the issue of XYZ be addressed.

DAWSS Development

The three events helped to define what was needed for management oversight and control. We initiated a project with the DLA Operations Research Office (DORO) to develop an analysis tool that provided a clear and distinct linkage between parts management and weapon/mission performance, and a variety of performance and diagnostic statistics.

Basic Intent

From the start, our primary objective was to field a usable system immediately. Rather than wait for development of better or more timely data, we intended to work with what we knew existed. In addition to those basic intentions, we set forth four basic conditions that governed the ultimate DAWSS structure:

(1) **The Intelligent User:** Because of limited resources, we did not develop pre- and post-processors. Rather, we assumed that the DAWSS users would be reasonably intelligent and computer-literate. This condition also allowed us to make the DAWSS more flexible, dynamic, and useful to managers.

(2) **Reliable Information:** There is a lot of information that could be accessed. However, one must be cautious because there are significant pieces of the data that are not reliable. That is, there are large gaps (missing data) or questions of accuracy in the data that cannot be resolved. Whenever the data was considered unreliable, we discarded that data and developed alternate methods.

(3) **Microcomputer Data Analysis:** Rather than rely on mainframe computers to perform all functions, the mainframe was used to pare down the vast amount of DLA data, perform rudimentary calculations, and provide a microcomputer-usable file. We decided to target the microcomputers with their database managers as the mechanisms to handle DAWSS information (compute trends, build reports, etc.).

(4) **ICP/Agency Connectivity:** The DAWSS products needed to be accessible at the ICP locations, because that is where corrective actions are actually initiated. Additionally, the results obtained at one location must be able to be replicated at other locations.

DAWSS Structure

The DAWSS structure can best be described as four major parts:

(1) **Data:** The central focus of the DAWSS structure is data access and manipulation. Because information is its central thrust, finding an appropriate database proved to be the most difficult. After sifting through a number of alternatives, we selected the DLA Integrated Data Bank (DIDB) as the best means to access and manipulate the various kinds of information necessary. The DIDB is the DLA archive containing a rich array of information on a variety of DLA processes.

(2) **Input Operations:** The method to manipulate the DIDB proved to be extremely challenging to the DORO analysts. To provide the necessary flexibility and simplicity, they designed a single screen that the user can easily edit. Once completed, the user initiates a DAWSS run with a single command, and data will be collected and products produced based on that input file. The various commands to call various files are transparent to the user.

(3) **Download Operations:** Two output files are created with each DAWSS run: a statistical file and a requisition file. The

Inventory Control Point (ICP)	Weapon System Demand Supported at < 50% Supply Availability	% of Demand Supported at < 50% in Five Worst FSCs	Five Worst FSCs
Defense General Supply Center (DGSC)	18.0% of Demand	45%	1560,1680, 6135,6220,6240
Defense Construction Supply Center (DCSC)	16.0% of Demand	57%	2510,2530, 2540,4720,4730
Defense Industrial Supply Center (DISC)	10.5% of Demand	64%	5305,5306, 5310,5330,5340
Defense Electronics Supply Center (DESC)	6.9% of Demand	54%	5905,5930, 5935,5945,5962

Figure 2. Five Worst FSCs with Low Support, 2nd Quarter, Fiscal Year 1992.

statistical file contains summary information. The requisition file contains an abbreviated requisition line for each backordered requisition. In order to use either file, the information must be downloaded from the DIDB and uploaded onto a microcomputer. The method of download differs by ICP; however, the files are "flat files" without headings and ready for immediate import into a microcomputer database manager.

(4) **Microcomputer Analysis:** The growing power of the microcomputer and the availability of microcomputers led us to rely on microcomputing power to perform analyses and trends. Out initial efforts have been successful using dBASE III-Plus. However, any database manager can be used. By structuring the output for microcomputer use, users will be able to perform more sophisticated analyses as the software becomes more sophisticated. Each additional user can tailor data anyway that is desired without cluttering up the mainframe files.

Limitations

As stated from the outset, the central objective was to field a "good enough" system NOW! We necessarily made decisions that limited capabilities and products. Three main limitations bound the DAWSS process. The first two relate to the DAWSS operation itself, while the third concerns data manipulation.

The data handling within DAWSS caused us to accept two limitations. First, the data is available quarterly. There was no practical way to improve on this in the short time available to develop and field this system. Second, the DAWSS runs are normally run overnight making them available on a "next day" basis. Because we were running DAWSS on a borrowed mainframe, we had to be careful not to disrupt the normal workdays of the hosts.

As stated under our basic intentions, data reliability was important. As a result, our third limitation is that the wait time statistics would not include the transportation segment of the time. The stop time for all DAWSS wait time measures is the ship date (the date that DLA turns the parts over to a shipper). Because the transportation information was unreliable—for a variety of reasons—we decided to stop the measurement at a point in time that we could reliably count.

Input Options

DAWSS provides a number of input options—24 to be exact. The options can be mixed and matched according to data needs. The method of input is through a single screen, listing the options that can be edited and then run. The actual varying kinds of inputs fall into four categories: requisition data, stock number data, response measurement selection, and weapon system selection. The figures used throughout this section will show the actual input screen line in capital letters with a brief description of the various options available.

(1) **Requisition Data:** The first segment of inputs deals with defining the requisition population (Figure 3). The specific year and quarter are required. Beyond that, defaults are established to define the largest population. The user then edits this portion to scale down the data to only those requisitions of interest. The "Project Code" field, for example, could be used to pull only requisitions associated with specific projects (Desert Shield/Storm, Provide Comfort). The "RDD" field could be used to identify MICAP requisitions (N**) or overseas requisitions (999).

(2) **Stock Number Data:** The next segment of inputs (Figure 4) deals with the stock number population. The previous segment identified the requisitions, but were not specific against particular stock numbers. In this segment, the user answers that question. The user must identify the ICP stock numbers—which can include the whole Agency—to be contained in the DAWSS run. Beyond that, DAWSS again selects the largest population for the run. The user must tailor the data as necessary.

(3) **Response Measurement Selection:** Within this segment (Figure 5), some choices in the array of outputs are available. The "Age of Requisition" field is designed to enable the user to identify how many requisitions fail within a user-defined time criteria. If, for example, the user wants to know how many MICAP requisitions exceeded 15 days, setting the "Age of Requisition" at 015 would capture that information (providing the requisition and stock number segments were properly defined). The "Supply Availability" field is similar but primarily provides stockage effectiveness considerations. It was necessary to offer as many outputs as possible. Earlier, this article discussed the ship date as a useful stop time for all requisitions. The "Order-Ship-Time" or "ICP-Response-Time" field allows the user to identify the start time. The date on the requisition is the "Order-Ship-Time," and the date the ICP actually receives the requisition is the "ICP-Response-Time."

(4) **Weapon System Selection:** The final input area deals with weapon system data (Figure 6). This segment applies if the user entered a "Y" for the "WSSP Only" field under the stock number data segment. The fields exist to provide methods to segment the performance information. Again, the defaults are set to pull down the largest amount of information.

Output Products

There are two types of output products provided by DAWSS: statistical and requisition. The formats and methods of calculation are identical for each DAWSS run. As a result, the figures produced within each DAWSS run can be easily compared to other runs and other options. Our intent was to make building trends and performing rapid analyses very easy.

Statistical Files

The statistical files contain such summary information as demands, backorders, wait times, and dollar values. All summary information pertains to the activity generated during the quarter selected and is segmented by Issue Priority Group (IPG). Each output contains a minimum of three lines: IPG 1, IPG 2, and IPG 3. The output information for each portion falls into three major blocks.

(1) **Population Block:** Each input option that is exercised creates output permutations. The first part of the output will identify those options that were exercised. For example, if all FSCs for essentiality codes 1 and 3 were selected, the output would resemble Figure 7. The number of lines of output would lengthen as the number of options is selected.

(2) **Transaction Block:** For the population selected, specific requisition, backorder, and availability failure criteria are displayed (Figure 8). The requisition and backorder data reflect requisitions received and backorders established during the quarter specified. The availability information reflects the performance of those stock numbers that fail the user-specified criteria. Again, the information is segmented by IPG. Within each major category, however, the information displayed is similar. The stock numbers that had transactions during the quarter (NSNCNT), the requisition lines (RQNCNT), the requisition units (RQNQTY), and the dollar values of the requisitions in thousands (RQNVAL) are all displayed for each category.

(3) **Shipment Block:** For the population specified, the requisitions and backorders that were closed out during the

1. FISCAL YEAR QUARTER FOR REQUISITIONS (YYQ)=: The user can select any one quarter for statistics, using a two-digit year and one-digit quarter code.
2. TYPE (OPEN,CLOSED,DEFAULT=ALL)=: The requisitions examined can be only open, only closed or all requisitions for the quarter selected.
3. MODE (DEPOT,VENDOR,DEFAULT=ALL)=: Closed requisitions filled by depot (D) or direct vendor delivery (V) can be selected.
4. CANCELLED REQUISITIONS EXCLUDED (Y,N,DEFAULT=N)=: Cancelled requisitions can be excluded if desired.
5. OLD REQUISITIONS EXCLUDED (Y,N,DEFAULT=N)=: Requisitions with birth date prior to the quarter selected can be included or excluded.
6. B/O CODES CONSIDERED (LIST ANY,DEFAULT=ALL)=: The user can specify selection of BB backorders, BV backorders or all backorders for analysis.
7. PROJECT CODE (LIST ANY,DEFAULT=ALL)=: Up to 10 three-digit, valid project codes can be selected per DAWSS run.
8. RQN CC–40 VALUE (CARD COLUMN VALUE, DEFAULT=ALL)=: The user can specify a select value in card column 40 of the requisition. This is normally to identify Navy CASREP requisitions.
9. RDD REQUIRED DELIVERY DATE (LIST ANY,DEFAULT=ALL)=: Up to 10 different RDDs can be selected per DAWSS run to include "999", "777", "N**", etc.
10. SERVICE-FIRST POSITION OF DODAAC (LIST ANY,DEFAULT=ALL)=: A one position value, "F" is entered to capture only Air Force requisition.
11. DODAACS (LIST ANY,DEFAULT=ALL)=: Up to 20 stock record account numbers (SRANs) or bases can be entered for any DAWSS run.

Figure 3. Requisition Data.

12. ICP FOR REQUISITIONS (X)=: A one character field, each DLA Supply Center or all Center transactions can be evaluated.
13. WSSP ONLY (Y/N,DEFAULT=N)=: A "Y" specifies only weapon system program requisitions while "N" specifies all DLA requisitions.
14. SSC (LIST ANY,DEFAULT=ALL)=: Up to 20 Supply Status Codes can be entered for evaluation.
15. MANAGEMENT ASSUME DATE RANGE (DEFAULT=ALL)=: Used to identify items assumed by DLA management, the following format identifies the Julian date (#####) range: #####-#####.
Consumable item transfer stock number and new item performance can be identified through this field.
16. FSCS (LIST ANY,DEFAULT=ALL)=: Individual federal supply classes can be identified, or "FSCS" can be entered to obtain FSC statistics for each FSC that had requisition activity.

Figure 4. Stock Number Data.

17. AGE OF REQUISITION (> XXX DAYS,DEFAULT 999)=: 010 015 020. Establishes failure criteria for wait time statistics. Three entries are required—one for each IPG: 1 2 3. The values establish the maximum allowable time for a requisition. Failures are captured in an output summary field.
18. SUPPLY AVAILABILITY FOR NSN (< XX%,DEFAULT –1)=: 50 50 50. Establishes the failure criteria for supply availability. Three entries are required—one for each IPG: 1 2 3. Stock numbers that fail to meet these minimum availability standards are captured in an output summary field.
19. ORDER-SHIP-TIME (0) OR ICP-RESPONSE-TIME (1)=: Used to establish the start time for "wait time" calculations. "0" sets the start time as the date of the requisition. "1" sets the start time as the date the requisition is received at the ICP.

Figure 5. Response Measurement Selection.

20. YEAR AND QUARTER FOR WEAPON SYSTEM INFORMATION (YYQ)=: The year and quarter for the weapon system program must be entered for weapon system-specific statistics. Normally, this value will be the same as the FISCAL YEAR QUARTER FOR REQUISITIONS.
21. WEAPONS LIST (DEFAULT=ALL)=: Up to 2,000 three-digit weapon system codes can be listed for separate output statistics.
22. WPN SYSTEM SERVICE (DEFAULT=ALL)=: Specify a one-character service code. For Air Force figures, enter an "F."
23. ESSENTIALITY CODES (DEFAULT=ALL)=: Specify the single character essentiality codes here. DAWSS will segment the summary information by essentiality code.
24. UNIQUES ONLY (Y/N,DEFAULT=N)=: Enter a Y or an N. A "Y" will cause statistics only for those stock numbers that are linked to a single weapon system.

Figure 6. Weapon System Selection.

FSC	RQN SVC	WPN SVC	WPN ESS	IPG
1560	F	*	1	1
1560	F	*	1	2
1560	F	*	1	3
1560	F	*	3	1
1560	F	*	3	2
1560	F	*	3	3
..	.	.	.	.
..	.	.	.	.
..	.	.	.	.

Figure 7. Population Block.

		ALL REQUISITION		
IPG	NSNCNT	RQNCNT	RQNQTY	RQNVAL
1	141	235	571	27
2	89	180	342	19
3	637	2549	6001	119
		B/O REQUISITION		
IPG	NSNCNT	RQNCNT	RQNQTY	RQNVAL
1	165	250	550	25
2	40	65	121	11
3	210	541	1770	76
		< XX AVAILABILITY		
IPG	NSNCNT	RQNCNT	RQNQTY	RQNVAL
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0

Figure 8. Transaction Block.

		ALL RQNS SHIPD		
IPG	AVGAGE	SHPCNT	SHPQTY	SHPVAL
1	14.45	1400	11500	200
2	23.40	3000	19700	389
3	18.75	3800	23500	421
		B/O RQNS SHIPPED		
IPG	AVGAGE	SHPCNT	SHPQTY	SHPVAL
1	21.93	108	6784	200
2	32.45	281	24796	231
3	29.62	273	31632	281
		> XX RQNS SHIPPED		
IPG	AVGAGE	SHPCNT	SHPQTY	SHPVAL
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0

Figure 9. Shipment Block.

quarter are displayed (Figure 9). Wait times are computed for the total requisitions shipped and, of that total, the number that were backordered. Those requisitions that exceeded user-defined standards are also identified with an average wait time for those that exceeded standards. Again, the information is segmented by IPG. The fields within each major category are identical. The average age or wait time (AVGAGE), requisition lines shipped (SHPCNT), units shipped (SHPQTY), and dollar value of the shipments in thousands (SHPVAL) are displayed within each major category.

Requisition Files

The summary information goes no lower than supply class level and base level. This provides a useful guide to addressing system problems. However, once the supply class has been identified, specific stock numbers are needed to begin attacking the overall supply class problems. The second file created from a DAWSS run addresses that issue.

A requisition file, using an abbreviated requisition line, contains all requisitions for which a backorder was created or that failed the user-defined wait time criteria. The file is, once again, a flat file that could be imported into any microcomputer database manager. The format (Figure 10) displays sufficient information to allow a great deal of analysis regarding problem stock numbers and potentially critical items.

Present Uses and Future Directions

The creation of DAWSS is a starting point toward improved visibility and control over DLA operations—but it is only a start. While the DORO analysts should be commended for producing such a high-quality, useful product in such a short time, DLA and the Services must begin to use this system and to expand its capabilities.

Present Uses

This system is a first step toward HQ DLA and HQ USAF/major command (MAJCOM) visibility and control over DLA processes. DAWSS provides ample capabilities to perform a number of MAJCOM-required analyses. Key issues, such as the Consumable Item Transfer, support to individual MAJCOMs, MICAP support, and critical item problems, can all be addressed in a systemic manner. Trends can be captured and support to key projects, bases, and systems can be evaluated.

A real-world example might provide some insight into some uses of this system. Consider, for a moment, the variety of DLA support provided to the Pacific Air Forces (PACAF), Air Combat Command (ACC), and Air Mobility Command (AMC). Is the support similar? If problems exist, where are they? We selected ten sample bases from each MAJCOM and produced DAWSS runs for the 2nd Quarter of Fiscal Year 1993. The MAJCOM totals (Figure 11) indicate that AMC is supported at a lower issue effectiveness rate than other MAJCOMs. Issue effectiveness—the support rate of stocked and nonstocked requisitions—was selected as a more meaningful measure of customer support. Issue effectiveness reflects the total customer demands immediately supported by DLA. In this manner, all DLA-supported requisitions can be evaluated. Given that change in emphasis, how are the individual bases faring with DLA support? Figure 12 replicates the MAJCOM worst case performance categories for the five individual bases in the issue effectiveness area. We now know that Travis AFB and Dover AFB have DLA-related support problems.

The next question is, within DLA, where are the key support problem areas? Again, the DAWSS runs provide ready answers. Almost 45% of the backorders established during the quarter fall within five FSCs (Figure 13). And, if we look at poorly supported stock numbers, a ratio can be used to rank the FSCs that have the highest ratio of poorly supported stock numbers to stock numbers ordered by AMC (Figure 14).

Field	Description

DEFENSE SUPPLY CENTER - A one-character field that identifies the DLA Supply Center with management responsibility for the national stock number.

NATIONAL STOCK NUMBER - The national stock number ordered.

ITEM NOMENCLATURE - The stocklisted description of the national stock number.

REQUISITION QUANTITY - The units or number of items requisitioned.

REQUISITION DOCUMENT - The entire document number including the requisitioner's address, requisition date, and requisition serial number.

UNIT PRICE - The cost of each unit that was ordered. The figure is listed in cents.

ISSUE PRIORITY GROUP - The one character field contains a 1, 2, or 3 indicating one of three priority criteria that each requisition falls within.

REQUISITION TIME - Lists either the order and ship time or the ICP response time, as specified in the input fields.

FAIL TIME CRITERIA - A one-character field that indicates whether the listed requisition failed the backorder time criteria listed in the input parameters.

FAIL BACKORDER CRITERIA - A one-character field that indicates whether the listed requisition failed the backorder criteria.

Figure 10. Requisition File Format.

MAJCOM	Issue Effectiveness	Wait Time (Days)	B/O Time (Days)	Problem Items
PACAF	87.77	11.19	41.07	2355
ACC	85.27	13.15	46.83	2738
AMC	83.27	16.90	41.36	3350

Figure 11. DLA Support to Key MAJCOMs, 2nd Quarter, Fiscal Year 1993.

Base	Issue Effectiveness	Wait Time (Days)	B/O Time (Days)	Problem Items
Dover AFB, Delaware	76.55	13.16	46.68	411
Travis AFB, California	80.63	16.97	46.07	942
McGuire AFB, New Jersey	83.52	19.03	38.36	416
Charleston AFB, South Carolina	84.19	21.45	40.70	379
McCord AFB, Washington	84.66	17.03	42.13	408

Figure 12. Five Worst AMC Bases in Issue Effectiveness Area.

FSC	Description	Issue Effectiveness	Wait Time (Days)
6135	Batteries, Nonrechargeable	41.60	21.85
1680	Miscellaneous Aircraft Accessories & Components	59.63	15.64
1560	Airframe Structural Components	61.99	15.71
1730	Aircraft Ground Service Equipment	68.89	14.61
6220	Electrical Vehicular Lights, Fixtures	69.72	16.18

Figure 13. Five Worst FSCs in Issue Effectiveness.

FSC	Description	NSNs with Requisitions	Problem NSN Ratio (%)
6135	Batteries, Nonrechargeable	132	51.52
1680	Miscellaneous Aircraft Accessories & Components	478	32.64
1560	Airframe Structural Components	918	28.65
6240	Electrical Lamps	564	26.95
6220	Electrical Vehicular Lights, Fixtures	350	24.57

Figure 14. Five Worst FSCs With Poorly Supported Stock Numbers.

We could repeat this exercise for any of the information in Figure 11. For that matter, we could have continued this exercise down to the stock numbers in question. Similar analyses could be performed for MICAP requisitions or key events for which there were project codes (Desert Shield/Storm, Provide Comfort). The input options provide for a vast array of information virtually at one's fingertips. Once the DAWSS files are produced, this information can be manipulated—and combined with previous, different runs—to provide substantial insights into DLA support.

Future Directions

Without question, DAWSS is a valuable tool, providing insights into the performance of DLA. However, this is only a first step. Both near-term and long-range actions will be needed to improve this technique. Fortunately, efforts are underway within DLA to address many of these areas.

In the near term, DLA must make DAWSS an integral part of the DLA management process. Primarily, they must begin the process of educating the DLA ICPs and the Services as to the availability of this system. Additionally, they must develop and use the more meaningful kinds of measures within DAWSS to influence DLA support. Already, HQ DLA has initiated discussions with the DLA ICPs to review and adjust weapon system-based management measures using DAWSS. More efforts such as this will follow as the various offices within DLA and the Services become more aware of DAWSS capabilities.

There must be a number of long-range actions to expand the capabilities of DAWSS. At present, a DLA ICP, HQ DLA, or DORO must make the DAWSS runs. No Service has direct access. Over time, however, that must change. DLA has considered establishing DAWSS on a separate computer with local area network access by DLA and Military Service users. While these discussions are at the preliminary stages, direct access to the Services will come eventually. Additionally, the information must become more timely to be most useful. Quarterly is sufficient as a starting point, but monthly data is better. Again, discussions have already begun within DLA to address that issue. As DAWSS continues to evolve, these long-range considerations will markedly improve the usefulness of the system.

Conclusion

Visibility and control are critical to large logistical operations. The consolidations within the DOD will make DLA a more central player in any Service logistical operation. Maintaining some control over that DOD Agency requires specific knowledge as to past and present performance. More importantly, managers within DLA and the supported Services must have access to information in a timely manner. Support patterns for a wide variety of contingencies and operations must be readily available to all managers.

DAWSS will provide that kind of governing information. Information necessary at the various command and supervisory levels is available and, more importantly, linked. Managers will have a better grasp of critical problem areas and can pinpoint key FSCs and stock numbers adversely impacting support. With DAWSS use within both DLA and the Services, problems will be more readily identified—and more easily targeted and resolved. The results: better support for the Services and better management oversight within DLA.

Lieutenant Colonel Ogan wrote this paper while attending AWC, Maxwell AFB, Alabama.

Opportunities for Military Services to Consolidate Support Functions

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Introduction

In a July 1992 speech before his colleagues in the United States Senate, Senator Sam Nunn, Chairman, Armed Services Committee, called for a thorough overhaul of the roles and missions of the Services. This requirement, he asserted, was prescribed by three primary forces:

(1) The changing world order—redefining our national security requirements.

(2) New technologies—providing greater opportunity for change.

(3) Public mandate—balancing the federal budget. (4:624)

Given these forces for change, the Department of Defense (DOD) faces significant budget cuts with fewer military and civilian employees. Therefore, we must search for innovative ways to provide for national defense and use our budget dollars wisely.

In response to Senator Nunn's request and Title X, United States Code (as amended by the Goldwater-Nichols Department of Defense Reorganization Act of 1986), the Chairman of the Joint Chiefs of Staff submitted a February 1993 *Chairman of the Joint Chiefs of Staff Report on the Roles, Missions, and Functions of the Armed Forces of the United States*. This 118-page document devoted less than three pages to support functions of the Services, reviewing construction engineer, chaplain, and legal functions. (6:44,48-49) According to the General Accounting Office (GAO), support functions cost DOD about $12 billion in fiscal year 1978 (9:1) and $18 billion in fiscal year 1983. (7:1) Assuming inflation, today's cost may approach $30 billion. A declining force structure, coupled with a significant decrease in funding levels, is driving DOD to find ways to reduce expenditures while still maintaining readiness.

This paper examines support functions of the Services to determine where consolidating, streamlining, or contracting out can provide more efficient and effective use of limited resources for all branches of the military. Since most of these initiatives are directed top-down from the Pentagon or an intermediate headquarters, this paper views the issues primarily through the eyes of Army and Air Force installation commanders—those tasked to implement these often-controversial initiatives.

As background, the Defense establishment is taking steps toward improved efficiency through four similar, yet divergent, programs: (1) the Defense Retail Interservice Support (DRIS) program, (2) Defense Management Reports (DMR), (3) intraservice streamlining initiatives, and (4) Office of Management and Budget (OMB) Circular A-76, "Performance of Commercial Activities" (also known as "CITA" or "Contracting Out"). The first two programs seek consolidation of support functions, but their approaches are dramatically different. We will discuss these programs briefly, but will focus on the DRIS program since it is probably the least-known initiative. While all four programs seek fiscal and manpower savings across the defense spectrum, they do not represent a coordinated effort at any level.

Given this mandate for change and historic inability to make these programs work in a coordinated fashion, we will present the opinions of Army and Air Force installation commanders—not only on consolidating support functions, but also on streamlining or contracting them out. Survey results are presented in tables and quotes. The conclusions are drawn from analysis of survey data and represent the views of the authors in their interpretation of that data.

Since an understanding of past successes and failures is important to comprehension of the difficulty in making these initiatives work, a discussion of background is essential.

Background

The *Base Structure Annex to Manpower Requirements Report for FY 1982* defines Base Operations Support (BOS) as ". . . all overhead functions which do not directly contribute to the mission accomplishment of combat units and tenants on Department of Defense (DOD) installations, activities and facilities." (5:5) In a 1980 US General Accounting Office report to the Secretary of Defense, base support services are defined as ". . . payroll and administrative activities, base supply and transportation, maintenance and construction of buildings and roads, trash and sewage disposal, and personnel management." (9:i) A detailed list of potential interservice support functions is included in the 15 April 1992 DOD Instruction 4000.19, *Interservice, Interdepartmental, and Interagency Support*, which prescribes the DRIS program. (8) Eliminating duplication of base support services without impairing mission effectiveness would generate significant savings to DOD.

Newspapers, magazines, and military publications are replete with articles discussing how much DOD spends annually, how much we waste, and how badly we need to change. Yet, the Military Services seem to be going in at least four different directions to achieve any semblance of savings—either in dollars or manpower spaces for the future. Furthermore, DRIS, DMR, intraservice streamlining, and A-76 are not new programs. The DRIS program, for instance, has been around since 1972. (7:8) Why then, have we not seen greater success in consolidating support functions? In his 1982 testimony before the House Committee on Government Operations, Mr Werner Grosshans, a Deputy Director with GAO, listed seven reasons for the limited success of the DRIS program:

(1) Lack of DOD commitment to the program.

(2) DRIS is a voluntary program and parochial interests exist at all levels—the Services, commands, and installations.

(3) Low level of involvement at the local level.

(4) Lack of meaningful goals.

(5) Lack of visibility of successes and mandates to implement these at the other locations.

(6) Projects selected for consideration normally are not the candidates that offer the highest payoff. They tend to be the ones that are least controversial.

(7) Failure to effectively coordinate the three competing programs: DRIS, CITA, and intraservice. (7:21-22)

While DOD commitment has increased since 1982, Service parochialism is still a major factor. Consolidation studies do not bring joy to the hearts and minds of military leaders. Each initiative is met with the feeling, "What am I going to lose this time?" Commanders feel competing pressures to achieve a high level of support for their people while trying to streamline, regionalize, or consolidate—and show significant savings. Concurrently, commanders must explain to military and civilians assigned to the bases that changes may affect their job security. It is far easier to wait until streamlining or consolidating is directed by a higher authority. Cost avoidance is one thing—deleting positions from the payroll is quite another. The DRIS program has given the local commander options but was not directive in nature. Therefore, local commitment was not obligatory.

As part of the DRIS program, regional Joint Interservice Resource Study Groups (JIRSG) were formed to help eliminate duplicative support functions. The Defense Audit Service's 31 March 1982 report on the audit of the DRIS program states that not a single consolidation occurred because of a JIRSG's actions. Material furnished later as a result of committee testimony revealed that the JIRSG program produced 570 studies since its beginning in 1978. The total personnel cost of those studies was approximately $700 thousand. (7:21-22) Research reveals many unsuccessful attempts to consolidate, regionalize, save, and institute cost-avoidance procedures—with very few success stories.

One success occurred, however, with the consolidation of Base Operations Support in Panama. In all, 158 positions were deleted with expected savings of over $4.7 million. An additional $2.6 million annual savings were possible if an agreement could be reached for centralized procurement. (1:iii) Implementation costs were only a small fraction of the $7.3 million savings. Why then, were these logical measures not implemented years before? Senior military leadership only took action after the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) directed the consolidation of real property maintenance and family housing in Panama, and indicated that other BOS activities must be studied. Three previous studies concerning Family Housing Management (1977 and 1979) and Civilian Personnel (1981) failed to spur the Services into an interservice agreement. Once directed by the Department of Defense, 19 bases, clustered in two small geographical areas, examined 8 BOS functions: civilian personnel; transportation; vehicle maintenance; food services; morale, welfare and recreation; Class VI beverage stores; purchasing and contracting; and law enforcement. The results showed the potential for over $7 million in savings. (7:2-5) In addition, conclusions of this consolidation study have implications throughout DOD.

A similar case study in consolidation potential occurred in the Sacramento, California, area. Within a 60-mile radius of Sacramento, there were seven military installations ranging in strength from 1,430 to 16,750. Major support activities accounted for the following number of personnel assigned:

Civil Engineering	2,629	
Base Contracting	281	
Personnel	624	
Vehicle Operation and Maintenance (O&M)	731	
Comptroller	763	
Data Automation	725	
Base Supply	1,591	
Security	747	
TOTAL	8,091	(9:26-29)

The GAO used this area as only one example where similar functions, located within a relatively small radius, could be consolidated, thereby saving manpower spaces while maintaining Service readiness goals. Between 1980 and June 1982, 13 DRIS studies had been conducted in the Sacramento area with 5 studies pending; but none of the completed studies resulted in new consolidations of base support functions. (7:2-5) Similar results were accomplished in the Norfolk, Virginia, area during the same time period. Review of committee hearings through 1992 revealed no evidence of either area ever accomplishing the stated goals of DRIS.

Another major consolidation effort is reflected in a vast collection of DMRs. Most of these reports are actively being studied or implemented within DOD. They date back to February 1989 when President Bush, in an address before Congress, charged the Secretary of Defense with reviewing defense management practices in light of the Packard Commission Report. Secretary Dick Cheney responded with the Defense Management Report to the President, implementing sweeping changes to defense management and promising a process of continuous improvement. (2:8) That was the genesis of the DMR program.

The program has been tremendously successful, with projected savings of approximately $53 billion through fiscal year 1995. Most of these savings are to be generated through big-ticket items like a consolidated Corporate Information Management (CIM) program designed to integrate all Defense information, data processing, and telecommunications systems. According to former Deputy Secretary of Defense Donald Atwood, two principles are responsible for DMR's success: centralized policy-making and decentralized responsibility for implementing management change. (3:40)

Of the four competing programs, most of our previous discussion has focused on the DRIS program. While the DMRs, contracting out, and intraservice streamlining actions also have mixed records of success, the DRIS program is more closely related to consolidation of support functions at the installation level. DOD Instruction 4000.19 reissues policies and procedures for the DRIS program, providing much more specific guidance on functions of the Joint Interservice Regional Support Groups. (8) Nevertheless, the initiative to make the program productive still seems to rest at the local installation level.

During his 1982 testimony before the House Committee on Government Operations, a Deputy Director with GAO described how contracting out under OMB Circular A-76 has frequently taken precedence over consolidation initiatives under DRIS. The GAO recommendation included consideration of streamlining or consolidating prior to an A-76 study. (8) This approach seems to hold the greatest potential for improved efficiency.

Our survey was mailed to 130 Air Force and Army senior officers—primarily installation commanders and a few senior staff members. Survey participants were asked to rate, using a numerical scale, their support for (1) consolidating, (2) streamlining, or (3) contracting out a limited selection of 42 support functions. The US Army Installations Management Office and Air Force Military Personnel Center concurred in our research and methodology, granting us access to their members for the survey. We attempted to persuade the US Navy to participate in the survey, but failed. After numerous letters, phone calls, and faxes, our request was elevated to Richard O. Thomas, Deputy Assistant Secretary for Shore Resources, Office of the Assistant Secretary of the Navy for Installations and Environment. He denied our request, stating that turbulence within the Navy regarding base closures would make it inappropriate to ask Navy installation commanders and senior staffs their opinions on consolidating, streamlining, and contracting out support functions. Therefore, our data reveals opinions held by US Air Force and US Army personnel only.

Of the 130 commanders and senior staff surveyed, 78 responded. There were 25 Army and 53 Air Force respondents, with a total of over 1,400 years of collective military experience. This return rate allows 99% confidence that the opinions of the entire group (130) are within 10% of the figures given. Tables 1-3 summarize the survey data for consolidating, streamlining, and contracting out support functions.

Leadership Issues

Although analysis of the survey responses proved very informative, some of the comments provided great insight into leadership issues. Some of the strongest arguments were based on peacetime versus wartime support requirements. Strong opinions back individual Services providing the best possible source of support functions while maintaining a

SURVEY RESULTS TABLE

CONSOLIDATING

	ARMY AVERAGE	USAF AVERAGE	OVERALL AVERAGE
Confinement/ Detention Facilities	7.3	6.2	6.5
Explosive Ordnance Disposal	7.5	5.7	6.3
Airline Ticket Office	6.7	5.8	6.1
Mortuary Services	7.0	5.6	6.1
Household Goods Shipment Services	7.3	5.3	5.9
Weather Services	7.7	5.1	5.9
Shuttle Services	6.4	5.7	5.9
Health Services	7.5	5.0	5.8
Automated Data Processing Services	6.8	5.3	5.8
Education Services	6.8	5.2	5.6
Communications Services	6.5	5.2	5.6
Vehicle Operations (Motor Pool)	7.2	4.6	5.4
Laundry and Dry Cleaning	6.6	5.0	5.4
Libraries	6.6	5.0	5.4
Chapel and Chaplain Services	5.4	5.2	5.3
Legal Services	6.7	4.6	5.3
Disaster Preparedness	7.1	4.3	5.3
Audio/Visual Services	6.5	4.7	5.3
Civilian Personnel Services	7.0	4.4	5.2
Purchasing and Contracting Services	6.8	4.4	5.1
Environmental Compliance Programs	6.5	4.5	5.1
Utilities	5.5	4.8	5.0
Vehicle Maintenance	6.5	4.3	5.0
Morale, Welfare, and Recreation Services	6.6	4.2	5.0
Installation Retail Supply and Storage	5.9	4.4	4.9
Refuse Collection and Disposal	4.9	4.7	4.8
Fire Protection	6.0	4.2	4.7
Administrative Services	5.9	4.1	4.6
Custodial (Janitorial) Services	4.9	4.5	4.6
Installation Safety Programs	6.7	3.6	4.6
Clubs & Other Revenue-Generating	6.6	3.5	4.5
Billeting Management	5.6	4.0	4.5
Food Services	5.5	4.0	4.4
Police Services (Law Enforcement)	6.2	3.6	4.4
Security	6.1	3.7	4.4
Civil Engineering Services	6.1	3.6	4.3
Training Services	4.1	4.2	4.2
Family Housing Management	5.4	3.3	3.9
Roads and Grounds Maintenance	4.7	3.5	3.8
Facilities Maintenance and Repair	5.1	3.3	3.8
Resource Management (Budget/Cost Analysis)	4.9	3.2	3.7
Military Personnel Services	4.1	2.9	3.3

1 STRONGLY OPPOSE — 2 — 3 OPPOSE — 4 — 5 NEUTRAL — 6 — 7 SUPPORT — 8 — 9 STRONGLY SUPPORT

Table 1.

SURVEY RESULTS TABLE
STREAMLINING

	ARMY AVERAGE	USAF AVERAGE	OVERALL AVERAGE
Military Personnel Services	7.2	6.5	6.7
Resource Management (Budget/Cost Analysis)	7.6	6.2	6.6
Environmental Compliance Programs	7.3	6.3	6.6
Civilian Personnel Services	7.2	6.3	6.6
Automated Data Processing Services	7.4	6.2	6.5
Security	7.1	6.3	6.5
Communications Services	7.4	6.1	6.5
Health Services	7.1	6.2	6.4
Training Services	7.3	6.0	6.4
Purchasing and Contracting Services	7.2	6.0	6.3
Facilities Maintenance and Repair	7.5	5.8	6.3
Morale, Welfare, and Recreation Services	6.6	6.1	6.3
Installation Retail Supply and Storage	6.9	6.0	6.2
Administrative Services	6.8	6.0	6.2
Clubs & Other Revenue-Generating	6.8	5.9	6.2
Confinement/ Detention Facilities	6.4	6.1	6.2
Police Services (Law Enforcement)	7.0	5.8	6.2
Installation Safety Programs	7.2	5.8	6.2
Civil Engineering Services	7.3	5.6	6.2
Billeting Management	7.0	5.7	6.1
Fire Protection	6.4	5.9	6.1
Family Housing Management	7.2	5.5	6.0
Disaster Preparedness	6.8	5.7	6.0
Roads and Grounds Maintenance	6.9	5.6	6.0
Vehicle Maintenance	6.2	5.8	5.9
Explosive Ordnance Disposal	6.7	5.6	5.9
Vehicle Operations (Motor Pool)	5.9	5.9	5.9
Household Goods Shipment Services	6.6	5.6	5.9
Legal Services	6.4	5.7	5.9
Education Services	6.7	5.5	5.9
Chapel and Chaplain Services	6.1	5.8	5.8
Audio/Visual Services	6.3	5.6	5.8
Utilities	6.2	5.6	5.8
Shuttle Services	6.4	5.5	5.8
Food Services	5.6	5.8	5.7
Weather Services	5.5	5.8	5.7
Airline Ticket Office	5.8	5.6	5.6
Mortuary Services	5.5	5.6	5.6
Libraries	5.7	5.5	5.5
Custodial (Janitorial) Services	5.4	5.2	5.2
Laundry and Dry Cleaning	5.4	5.1	5.2
Refuse Collection and Disposal	5.8	5.0	5.2

1 STRONGLY OPPOSE — 2 — 3 OPPOSE — 4 — 5 NEUTRAL — 6 — 7 SUPPORT — 8 — 9 STRONGLY SUPPORT

Table 2.

readiness posture necessary to deploy, fight, and win. The following comments highlight dramatic differences of opinion among Army and Air Force senior leaders:

Organic military capabilities are myths that do not reconcile themselves with myths of expeditionary Air Forces fighting from the CONUS. More consolidation will inevitably lead to more A-76 studies and more contracting out. Contractors cannot do most things as good as we can and all of them at lower cost. This is the essence of "defense conversion." The Services' parochialism and lack of support for Congressionally-driven efforts to consolidate and integrate will lead to Congressional control by underfunding. If we want to keep what we really need, we'd best get off the dime. We are resisting and that is irresponsible in the present (and future) environment. The USAF should be the DOD Executive Agent for all undergraduate pilot training, all space operations (launch, on-orbit control, constellation architecture design, satellite and launch vehicle procurement), all "air" depots, all legal services, and all billeting. Except for a few aerospace medicine and altitude chamber folks, we should give all military medicine to the Army. Air Force medical people never joined the Air Force and Military Indoctrination for Medical Service Officers (MIMSO) is a sad joke. Senator Nunn has seized the high moral and fiscal ground. What is good for the Air Force is not necessarily what's good for America. I'm very disappointed in our senior military leadership. A willingness to only make small changes on the margins trivializes us and our willingness to serve. The message is clear: adapt or die—let's adapt!

(Air Force, Installation Commander)

Consolidation across services may become a virtual reality based on budget. In ATC we've already contracted out many functions and face A-76 for BOS functions very soon, so contracting out is alive and well. As an installation commander, I tell you, you lose flexibility whenever things get consolidated (regionalized) or contracted. Frankly my preference would be to find ways to save manpower and money at the base level. Empower the commander to run the base vice taking authority and responsibility and giving it to some communist organization.

(Air Force, Installation Commander)

Thanks for the opportunity to participate in this survey. As you can see from my scores, I don't believe we have much additional opportunities for consolidation between the Services. We certainly don't need any more DOD agencies controlled by Pentagon folks that are not in contact with the field customers. I'd appreciate a copy of the results.

(Air Force, Senior Staff)

We need to consolidate where it is smart. I share the boundary to both Air Force and Navy bases. It is my experience that in most cases contracting out of vital services is the least desirable alternative; flexibility is lost and once out it will not be brought back in house.

(Army, Installation Commander)

I think we got sold a bill of goods that contracting out is cheaper and better. I think Service leaders better serve their soldiers and customers when it is Service run rather than consolidated. Big is not necessarily better or more efficient. Be careful on the consolidation. A better key is to let O-6 and equivalent civilians do more management, and do less micromanagement from the top, and hold managers accountable and

SURVEY RESULTS TABLE
CONTRACTING OUT

	ARMY AVERAGE	USAF AVERAGE	OVERALL AVERAGE
Refuse Collection and Disposal	8.2	8.0	8.1
Custodial (Janitorial) Services	8.0	7.9	8.0
Laundry and Dry Cleaning	7.8	7.6	7.7
Airline Ticket Office	6.6	7.2	7.0
Shuttle Services	5.8	6.6	6.4
Food Services	6.4	6.4	6.4
Libraries	6.2	6.4	6.4
Utilities	6.3	6.3	6.3
Roads and Grounds Maintenance	6.4	6.1	6.1
Audio/Visual Services	6.3	6.0	6.1
Household Goods Shipment Services	5.3	6.2	6.0
Vehicle Maintenance	6.2	5.7	5.8
Education Services	5.5	5.8	5.7
Billeting Management	5.3	5.7	5.6
Vehicle Operations (Motor Pool)	6.2	5.1	5.4
Family Housing Management	4.1	5.7	5.3
Facilities Maintenance and Repair	5.8	5.1	5.3
Clubs & Other Revenue-Generating	5.7	5.1	5.2
Automated Data Processing Services	5.6	5.1	5.2
Mortuary Services	6.1	4.8	5.2
Morale, Welfare, and Recreation Services	5.1	5.1	5.1
Installation Retail Supply and Storage	5.2	4.7	4.9
Weather Services	5.8	4.5	4.8
Fire Protection	5.6	4.2	4.6
Civil Engineering Services	4.1	4.5	4.4
Purchasing and Contracting Services	4.3	4.4	4.4
Training Services	3.5	4.7	4.4
Administrative Services	4.1	4.4	4.3
Environmental Compliance Programs	3.7	4.6	4.3
Confinement/ Detention Facilities	4.4	4.3	4.3
Communications Services	4.8	4.0	4.2
Health Services	4.2	4.2	4.2
Installation Safety Programs	3.9	3.4	3.6
Civilian Personnel Services	2.9	3.6	3.4
Police Services (Law Enforcement)	2.9	3.5	3.3
Disaster Preparedness	2.8	3.4	3.2
Legal Services	3.6	2.9	3.0
Resource Management (Budget/Cost Analysis)	2.7	3.1	3.0
Security	3.5	2.8	3.0
Explosive Ordnance Disposal	2.7	3.0	2.9
Military Personnel Services	2.4	2.3	2.3
Chapel and Chaplain Services	2.0	2.3	2.2

1 2 3 4 5 6 7 8 9

STRONGLY OPPOSE — OPPOSE — NEUTRAL — SUPPORT — STRONGLY SUPPORT

Table 3.

responsible for their decisions. Use the Air Force model for Civil Engineering Services. All installation CPOs (civilian personnel offices) could be consolidated into one office. All civilians should be serviced locally, and there is no need for each Service to have its own personnel office.

(Army, Subordinate Commander)

Contracting out certain services is inappropriate for wartime due to the necessity of supporting individuals who are in close proximity to combat operations.

(Army, Installation Commander)

Keep the deployable aspects of all these functions as Air Force resources. I would not contract out or consolidate anything that has a mobility tasking which is essentially where we appear to be headed, particularly in Civil Engineering functions. The CORE wing gets us to a deployable combat function and "stay home essential services" that will be either DOD (consolidated), contracted, or civilianized. In my view, that's the correct approach given our current and projected fiscal guidance. The bottom line has to keep in it the tasked commander's flexibility to meet the unit's needs on a wartime footing, not on a day-to-day peacetime scenario. You should have a deploy, non-deploy column on the survey since that defines my answers more clearly.

(Air Force, Installation Commander)

I have seen family housing managed by Army, Navy, and Air Force—I have yet to see either Army or Navy housing that was kept to the worst I ever witnessed in 26 years in the Air Force. This is too close to taking care of the troops to risk a major reduction in quality! I have seen too many instances of double dipping and amateur performance on the part of commercial environmental companies to entrust our future to them at this point. I think this is one more area where a joint approach has merit. I realize I'm swimming against the current in healthcare, but this again is a people issue and I feel Air Force doctors take better care of Air Force people because they understand the environment in which they operate.

(Air Force, Installation Commander)

I strongly support streamlining all activities—that is what quality is all about—continuous improvement means streamlining. I support contracting if it improves the activity based upon cost. I do not support consolidation with other services, however, we need to learn from each other. I do not support consolidation because I think the Air Force is light-years ahead of the other Services in the areas you've listed. The Navy and Army could learn a great deal from the Air Force and that competition breeds improvement.

(Air Force, Installation Commander)

Household goods shipments: In the national capital region this function is already consolidated under "Joint Personal Property Shipping Office" (JPPSO)—works great! Consolidate/contract peacetime commissary, telephone, computer functions. Retain Services' tactical/battlefield commissary functions.

(Army, Installation Commander)

Consolidation of active duty functions with uniformed Service members will be exceedingly difficult. Each Service has a different culture. As an Air Force officer, I'm proud of what we've done and I don't want our standards of excellence "watered" down. If you march down this road, you have the Canadian example. Talk to them; they'll tell you the uniservice idea was/is a disaster.

(Air Force, Installation Commander)

The primary factor to be considered in a decision to contract out services must be the need for this service in an operational deployed situation. How would it be provided in the operational/combat environ-

ment? Sufficient inherent capability must be maintained in the uniformed military to accomplish/manage these tasks. With respect to consolidation, considerations must be given to the chain of command of these consolidated service organizations. Local commanders who are held responsible for the "care and feeding" of their people/organizations must have "live fire" authority over consolidated service organizations on their installation.

(Air Force, Installation Commander)

Environmental Compliance Program: DOD needs to act in unison with a coordinated, united approach and sense of urgency. Everyone needs to sing off the same sheet of music and the bucks need to be put where they are needed most.

(Army, Subordinate Commander)

In general, I view consolidation and contracting out as the wave of the future. However, as an installation commander, there are some areas I want full control of, such as MWR, supplies, food, etc. Generally, I want complete in-service control of those issues that affect morale or safety, or that may send me to jail. Consequently, any consolidation, streamlining, or contracting out that does not give me that is unsatisfactory.

(Air Force, Installation Commander)

I feel we should go a step further and consolidate multiservice activities on our larger bases. Beale AFB, California is, an example of a 23,000-acre facility with an impressive expansion capability. Joint activities on large bases provide us with even greater "economies of scale" in the future.

(Air Force, Installation Commander)

I tend to favor consolidation of services because of proximity to Pope AFB, North Carolina. Streamlining has been accomplished to the practical limits because of budget cuts. My experience with contracting services has not shown expected savings and generally give far poorer service to customers. We need to get on with this in Base Operations before we are told to do it!

(Army, Installation Commander)

Generally speaking, I believe all installation management services could be improved through a consolidation within all DOD agencies of a single manager for those services. This does not necessarily mean the centralization of services support in any greater degree than is already being studied. I believe, in most cases, each installation must maintain a certain level of installation service support at the post/base. I also believe contracting out large-scale, basic installation service support is no longer wise. With the declining DOD budget, I believe installation managers have less flexibility in adjusting their resources when they have contract support services than if they had a civilian or military workforce. One qualification to this statement is that obviously some adjustments need to be made to streamline the management of the civilian personnel system. Last, but not least, there is no question that every function is tied up with bureaucratic processes that cost time and money. Streamlining of all areas is a must to allow the installations to make the best use of what few people they have left.

(Army, Installation Commander)

Conclusions

A comprehensive analysis of survey response data revealed several easily discernible trends. For example, respondents from both Services see intraservice streamlining of support functions as necessary and viable alternatives. The top five candidate functions for streamlining were: (1) Military Personnel Services, (2) Resource Management (Budget/Cost Analysis), (3) Environmental Compliance Programs, (4) Civilian Personnel Services, and (5) Automated Data Processing Services.

Contracting out support functions, on the other hand, generally failed to evoke the same degree of consensus among respondents. Few candidates generated universal agreement, with the exception of functions that are already contracted out at most installations. The top five candidates for contracting out were: (1) Refuse Collection and Disposal, (2) Custodial (Janitorial) Services, (3) Laundry and Dry Cleaning, (4) Airline Ticket Office, and (5) Shuttle Services. Most of the commanders' concerns reflected contracted peacetime support falling short of wartime requirements.

The issue of consolidation presented the most diverse responses and comments. Overall, Army respondents view consolidation much more favorably than their Air Force counterparts. Almost without exception, Air Force respondents opposed consolidation of support functions.

The top five candidates for consolidating were: (1) Confinement/Detention Facilities, (2) Explosive Ordnance Disposal, (3) Airline Ticket Office, (4) Mortuary Services, and (5) Household Goods Shipment Services.

The most obvious differences of opinion along Service lines involved the consolidation question. Army and Air Force responses were much closer for streamlining and contracting out support functions. This Air Force aversion to consolidation may rise out of a Service culture built on fighting for independence for the first half of its existence. Nevertheless, the three forces for change outlined by Senator Nunn in his call for a roles and missions review do not bode well for a parochial perspective. The question remains: Will the Services voluntarily move to consolidate, streamline, and contract out support functions, or will they wait for budget cuts and top-down direction to force the issue? At this juncture, the Services still have choices—an opportunity to shape the future of support functions. While it may be less controversial to wait for directed guidance, the Defense Retail Interservice Support program provides commanders with a mechanism to work consolidation issues at the regional level.

References

1. Cushen, W. Edward; Dienemann, P. F.; Handy, J. B.; Harrington, E. R.; and O'Day, G. R. *Consolidation of Base Operations Support (BOS) in Panama*, Logistics Management Institute, December 1982.
2. "The DMR at Work: Toward Six Broad Goals," based on *Defense Management Report Implementation Progress Report*, 10 January 1990, *Defense* 90 (March - April 1990), pp. 8-15.
3. Jones, L. R. "Minding the Pentagon's Business," *Government Executive*, October 1992.
4. Nunn, Senator Sam. "The Defense Department Must Thoroughly Overhaul the Services Roles and Missions," *Vital Speeches of the Day*, 1 August 1992.
5. Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). *Base Structure Annex to Manpower Requirements Report for FY 1982*, January 1981.
6. Powell, General Colin L. *Chairman of the Joint Chiefs of Staff Report on the Roles, Missions, and Functions of the Armed Forces of the United States*, Washington DC: US Department of Defense (February 1993).
7. US Congress, House, Committee on Government Operations, Legislation and National Security Subcommittee; *Consolidation of Military Base Support Services*, 97th Cong., 2d sess., 1982.
8. US Department of Defense. DOD Instruction No. 4000.19, *Interservice, Interdepartmental, and Interagency Support*, 15 April 1992.
9. US General Accounting Office. *Consolidating Military Base Support Services Could Save Billions*, LCD-80-92, September 1980.

Lieutenant Colonels Glisson and Ferguson wrote this article while students at AWC. Colonel Glisson is currently Deputy Commander, 325th Support Group, Tyndall AFB, Florida. Colonel Ferguson is presently Chief, Plans and Resources Branch, Directorate of Information Management, SAF.

CAREER AND PERSONNEL INFORMATION

Civilian Career Management

The Changing Face of the Logistics Civilian Career Enhancement Program

The Logistics Civilian Career Enhancement Program (LCCEP) was conceived in 1974 and implemented in 1980. Since then, this program has grown and matured in its service to both registrants and managers.

Recently, several of the senior executives who were instrumental in the conception, implementation, and guidance of LCCEP have either retired or moved on to other duties. It is fitting that we pay tribute to these leaders; recognize those senior executives who have taken their place; and remind all registrants that they are, in fact, truly represented in all facets of LCCEP by dedicated senior logisticians.

Executives no longer associated with active LCCEP operations are:

Lieutenant General Trevor Hammond
Mr Lloyd Mosemann II
Mr Oscar Goldfarb
Mr Alan Olsen
Mr Earl Briesch

We thank these dedicated logisticians for their inspiration and guidance over the many years. Their participation in LCCEP was always an additional duty, one that required countless hours of effort, but which they undertook with pride and professionalism.

Executives who have superseded them include:

Lieutenant General John Nowak - DCS/Logistics (HQ USAF/LG)
Mr Gerald Yanker - Oklahoma City Air Logistics Center (OC-ALC/CD)
Ms Diann McCoy - Standard Systems Center (SSC/ED)
Ms Beverly Hooper - Directorate of Supply, Combat Support Doctrine Branch (HQ USAF/LGSP)
Mr Thomas Miner - Headquarters AF Materiel Command (HQ AFMC/LG)

We welcome these logisticians, knowing each brings to LCCEP the same high level of dedication and leadership.

Finally, we remind each registrant that they are currently represented by many other logisticians, from all levels of Air Force logistics work. These men and women serve registrants and managers by recommending, creating, or implementing logistics policy. Suggestions for improving LCCEP may be made either through them or through the PALACE Team at Randolph. The following organizations have representatives on either the Policy Council or one or more panels:

Air Combat Command (ACC)
Air Education and Training Command (AETC)
Air Force Command, Control, Communications and Computer Agency (AFC4A)
Air Force Intelligence Command (AFIC)
Air Force Materiel Command (AFMC)
Air Force Security Assistance Center (AFSAC)
Air Force Space Command (AFSPACECOM)
Air Mobility Command (AMC)
Aeronautical Systems Center (ASC)
Electronic Systems Center (ESC)
Materiel Systems Center (MSC)
Oklahoma City Air Logistics Center (OC-ALC)
Ogden Air Logistics Center (OO-ALC)
Pacific Air Forces (PACAF)
San Antonio Air Logistics Center (SA-ALC)
Sacramento Air Logistics Center (SM-ALC)
DCS/Logistics (USAF/LG)
US Strategic Command (USSTRATCOM)
Warner Robins Air Logistics Center (WR-ALC)
646 Air Base Wing

(Robert Olear, AFCPMC/DPCL, DSN 487-4088)

Logistics Professional Development

Logistics Support Officer Assignments Personnel Update

Personnel Update

Some recent changes have taken place in the Logistics Support Officer Assignments Branch at the Air Force Military Personnel Center (AFMPC). The assignments team (DPMRSL) is comprised of transportation, logistics plans, and supply officers. Lieutenant Colonel Joyce Egge is the team chief, and the team members are Major Cheryl Heimerman and Captain Toby Sieberlich, Transportation Officer Assignments; Majors Dave Smith and Ken Smith, Logistics Plans Officer Assignments; and Captain Dennis Crimiel, Supply Officer Assignments.

The Aircraft and Missile Maintenance Assignments Branch (DPMRSM) also has some new faces. This team is led by Captain (Maj Sel) Mark Atkinson, and team members are Captains Vince Lupo, Teresa Harrison, and Steve Shinkle, and MSgt Canter-Owen.

Elimination of the Air Force Form 90

Another change announced in the personnel world is the elimination of the Air Force Form 90 (Officer Assignment Worksheet). The Officer Voluntary Assignment System (OVAS) is now the primary means by which officers should

(Continued on bottom of page 26)

USAF Logistics Policy Insight

Initiatives in Acquiring Common Supplies and Services

A Defense Performance Review subcommittee of Vice President Gore's National Performance Review was tasked to determine where the Services could inject business-like, customer-oriented philosophy into DOD's business processes. One of the committee's goals was to identify enabling actions which could provide maximum flexibility to commanders and managers in acquiring common supplies and services. A few of the suggestions include raising the small purchase threshold from $25,000 to $100,000; increasing the credit card threshold from $2,500 to $10,000, while limiting the restrictions on their use; and removing most of the Services' constraints to the Federal Acquisition Regulations (FAR) and Defense FAR Supplements (DFARS). The Services plan to test these initiatives at various bases and sites throughout DOD. If these and other initiatives prove to have the benefits the committee members think they will, plan for some sweeping changes and simplifications to the way DOD currently does business. (Maj Nan Watson, AF/LGSS, DSN 227-5938)

Procurement of Initial Spares

Beginning in FY94, most initial spares (excluding engines, quick engine change (QEC) kits, classified programs) will be procured using obligation authority in the Defense Business Operations Fund (DBOF) AF Supply Management Business Area (SMBA). This is a dramatic departure in the way we do business. In the past, our initial spares investment account required full financing in the year the item was ordered from the contractor. In other words, if our computed requirement was 100, then we needed a like amount in investment dollars in that year. Beginning in FY94, DBOF AF SMBA will order the spares using DBOF contract authority; and the investment appropriations will be used to reimburse the DBOF AF SMBA based on asset deliveries. Historically, investment assets are delivered over a five-year period. This means that, instead of full financing every year, our initial spares investment account requires only 7.8% funding the first year, with the remainder spread over four years based on the estimated delivery profile. Beginning in FY94, all of the investment accounts have been adjusted to reflect estimated deliveries derived from a historical outlay model. This change does not impact base-level Depot Level Reparable (DLR) transactions. This process is used to provide the initial asset to the base supply account prior to use. Once a failure occurs and base maintenance needs the asset, it is sold at exchange price and the DLR replenishment cycle begins. (Maj Gregory Brown, AF/LGSW, DSN 225-2793)

(Continued from page 25)

convey their career and job desires to AFMPC assignment officers. Under OVAS, officers can volunteer for specific jobs on the Electronic Bulletin Board (EBB) by calling the appropriate assignments team, or by sending a fax, E-mail, message, or letter to them. Since the Form 90 has little worth under OVAS, it will no longer be used to provide preferences for routine assignment actions.

However, the Form 90 will still be used for special boards, such as officer professional military education (PME), Air Force Institute of Technology (AFIT) selection, and return-to-fly boards. Also, the Form 90 will undergo revision, be retitled the "Officer Preference Worksheet," and be redesigned to address specific board information. This change resulted from a MAJCOM Process Action Team (PAT) recommendation to eliminate the Form 90 as a vehicle for assignment selection.

Backfills for Vacancies Created by Early Retirement Boards

Some units will experience unplanned/unprojected vacancies created by selective early retirement boards and force structure drawdown programs (Variable Separation Incentive/Special Separation Benefit (VSI/SSB) and 15-year early retirement). In many cases, these losses will have a significant impact upon the unit's mission. Also, these losses are not projected by the AFMPC assignments teams nor do the teams know an officer has been selected for retirement until a date of separation has been established. To ensure vacancies are backfilled in a timely manner, we encourage commanders to contact their MAJCOM counterparts and identify projected vacancies as soon as possible. In addition, commanders can recommend alternate dates of separation for officers participating in VSI/SSB and the 15-year early retirement programs to lessen the impact of an unexpected loss upon their unit's mission. Once the MAJCOM passes the requirements to the assignments teams and the requirements are validated, the vacancies will be advertised on the EBB. This process alone may take a few weeks to develop. To avoid gaps in these positions, it is important these requirements are identified as soon as possible.

Supply Schoolhouse Move

The supply officer course moved from Lowry AFB, Colorado, to Lackland AFB, Texas, in October; and plans are to have the new course on-line in January 1994. The course is currently being revised and will now incorporate the fuels officer courses. As a result, all officers attending the new course will no longer have to attend separate fuels management courses if they are assigned to a fuels management position in base supply. This change will provide Chiefs of Supply more flexibility in the long term in assigning officers to the fuels branch of base supply. Overall, the entire supply community will benefit from this change since officers will be exposed to all aspects of supply and be more prepared to fill critical joint duty billets in the future.

(Capt Dennis M. Crimiel, AFMPC/DPMRSL, DSN 487-6417)

Innovative Logistics During the Past 50 Years

Captain Joni R. Lee, USAF

Introduction

Not everyone in the military has an opportunity to experience actual combat, so many must learn by studying the past. Military history is usually filled with the study and lessons of tactics and strategy, often overshadowing the importance of logistics. In combat situations during the past 50 years, logistics proved to be equal in importance to both tactics and strategy. In fact, General George S. Patton, Jr., said:

> ... the officer who doesn't know his communications and supply, as well as his tactics, is totally useless. (18:94)

Therefore, a study of past conflicts is not complete unless logistics is included.

Also, most military history is filled with lessons learned which tend to focus on what went wrong. It is important to study not only what went wrong, but also what went right! By looking at innovative logistics during conflicts of the past 50 years, one can gain both an understanding of the situation and an innovative way of carrying out a mission in a wartime situation.

Innovative Logistics

World War II

World War II was truly a "world" war with fighting occurring all over the globe. Since supplies, food, and ammunition had to be provided to troops throughout the world, logistics was a vital part of the US strategy. Logisticians often had to rely on ingenuity to meet mission needs or simply make their jobs easier.

The most amazing logistical feat during World War II was the construction of a harbor at Normandy in only six months. This harbor was a key factor in the Allies' successful invasion at Normandy. Huge cement barges or caissons were constructed in Britain, towed across the English Channel, and then sunk off the beaches at Normandy. Also, steel pontoon docks and pier heads were put together and called "mulberries," and were used for off-loading ships and landing craft. The entire harbor was designed and fabricated in less than six months and put together in only two weeks—a truly amazing feat, even by today's standards. (18:84,88,120)

Another truly amazing logistical act was the creation of a trucking supply system, the "Red Ball Express." This was an improvised system of using all trucks that could be spared to supply the armies racing across France. This overcame the shortage of transportation facilities by using half the French roads as one-way *into* the forward supply dumps and the other half as one-way *back* to the supply staging area in Normandy. Eventually, the same idea was used on the French railroads. This idea was so successful that it was to be used later (with some variations) in both the Vietnam and Persian Gulf Wars.

As evident from the harbor at Normandy and the Red Ball Express from Normandy, amphibious beach operations were a crucial part of getting supplies to troops. Because the harbors could only hold so many ships at one time, logisticians were constantly trying to develop new ways to get cargo onto the beaches. The outcome of their efforts was combat loaders, landing craft, and amphibious jeeps. Combat loaders carried specific cargo as close to the beach as possible, and landing craft could drive their cargo right onto the beach. (18:104) Both of these proved to be very useful and were major contributors to successful amphibious operations.

The development of an amphibious jeep was even more unique than the combat loaders and landing craft. The jeep itself (to be mentioned later) was a logistical "dream machine," so the idea of an amphibious one was even more exciting. This amphibious jeep became known as a DUKW, pronounced "duck."

The DUKW was a 6′ x 6′ truck equipped with a propeller and tires that could be inflated or deflated by the driver. This vehicle could carry 10 tons of cargo when afloat or 4 tons on the road, and it could use a winch to pull palletized loads or cargo sleds. Also, it could go 5 knots in the water or 50 miles per hour on land. Not only could the vehicle do all this, but it could also defend itself with 120 4.5-inch rocket launchers. (18:108-110)

Related to amphibious operations were the innovations of Naval logisticians. Since the Naval fleet was dependent on fuel and refueling had to be done at sea, the Navy developed roving fuel task groups and towed fuel barges. The roving fuel groups were in designated rendezvous areas, and they steamed in a rectangular pattern. Any ships entering the pattern were refueled. The towed fuel barges were used to move fuel into new areas and also to off-load fuel on shore when tanker ships could not move in close enough. (24:75)

Navy logisticians also developed a floating dry dock that was used to repair ships. This invention was a definite asset to ship maintenance personnel. These dry docks had power supplies, lighting for night-time repairs, repair shops, and quarters for 60 or more men. (24:106-107)

Additionally, the Navy developed the refrigerated barge for use in the Pacific. This barge could be moved by tug to wherever it was needed; then its contents could be off-loaded to a refrigerated provision's store ship. (24:113) This barge provided

The DUKW.

a modern-day just-in-time delivery function, plus it provided the ship stores with more flexibility to meet their mission.

Even though it was apparent that monumental efforts were being made to distribute supplies, some improvising was often required. A common practice was to "cannibalize" crashed aircraft for parts. Also,

> parts for aircraft, ships, engines, trucks, and so forth were frequently locally manufactured. Often these local parts lacked the niceties of commercial manufacture but they served to get equipment back into use rather then lie idle awaiting parts. (24:100)

The "jerrycan" was another innovation which served as a highly portable and tactically flexible method of distribution during battle. It was copied from the Germans and used by the Americans as an easy method to carry extra fuel as troops moved ahead of their supply lines. (18:123)

As mentioned earlier, the Navy developed floating dry docks to speed up the maintenance process. The Army Air Forces were also interested in not only speeding up their aircraft maintenance process but also in increasing reliability. This was accomplished with the development of a concept called Production Line Maintenance (PLM). This concept allowed an aircraft to be towed through a succession of maintenance stations where specifically trained crews worked on specific areas. This made aircraft maintenance more efficient and effective. (18:128)

When mentioning efficient and effective areas in logistics, probably the most efficient, effective, and versatile thing to come out of World War II was the jeep. Efficiency was evident since it rarely broke down beyond the driver's capability to repair. Its effectiveness and versatility were evident in its many uses such as the machine-gun platform, flatbed truck, small aircraft towing tractor, radio command post, and mini-bulldozer. It was also used as a medical evacuation vehicle with stretchers across the beam, fore, and aft, or in layers on racks on the back. (24:86-88)

Besides the jeep being used for medical evacuation, logisticians made several leaps in the medical arena. Mobile Army Surgical Hospital (MASH) units saw their birth during this war. These MASH units allowed surgeons to be near the field of combat, so soldiers received quick medical attention. Hospital ships were also used for the first time to care for the wounded. To transport wounded soldiers to the hospital ships, logisticians developed a new use for Landing Ship Tanks (LSTs). Several LSTs were stocked with medical supplies and had one medical officer and two corpsmen on board. This unique use of LSTs resulted in many lives being saved by quick and competent evacuation to hospital ships. (24:118-119)

All these logistics innovations during World War II helped to fulfill the mission and to make jobs easier. Each played a critical role in helping the Allies win the war. General Dwight D. Eisenhower understood the importance of logistics and, after the war, commented:

> You will not find it difficult to prove that battles, campaigns and even wars, have been won or lost primarily because of logistics. (1:10)

This statement would be proven again and again as the US involved itself in future conflicts.

Berlin Airlift

Three years after World War II ended, the US was involved in "Operation Vittles" which has become known as the Berlin Airlift. In less than a year, more than 275,000 sorties were flown with mostly C-47 and C-54 aircraft for a total of 2,300,000 tons of supplies! This huge effort definitely proved that airlift capability is an important aspect of our national defense and that the US needed airlift aircraft capable of carrying more cargo than normal. This became more evident when the Korean War began.

Korean War

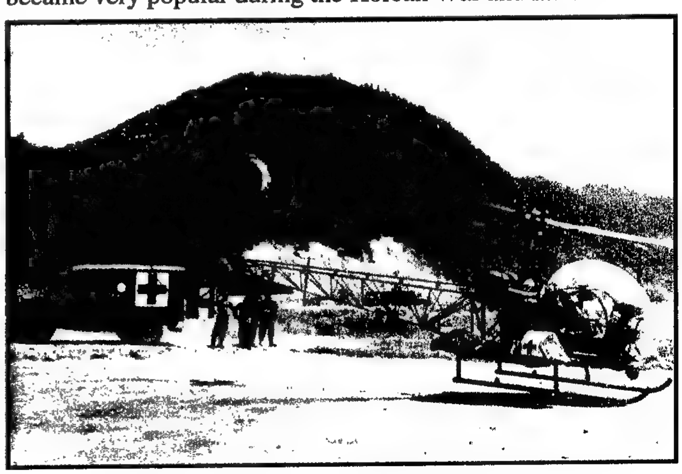
The Air Force's experience in the Berlin Airlift was a prelude to the long-range air supply pipeline formed during the Korean War. In fact, Major General William H. Tunner, commander of intratheater airlift, emulated the Berlin Airlift while moving supplies from Japan to Korea. He set up an airlift schedule with "landings and takeoffs every two minutes and by directing that pilots use instrument flight rules exclusively to ensure that the flow and route were meticulously accurate for every mission." (17:19) Also, aerial resupply of Marines at the Chosin Reservoir proved to be the only reliable means of supply; without airlift support, many more Marines would have died. (17:20)

While the need for airlift was becoming obvious to everyone, the Military Air Transport Service (MATS) did not have the capacity to meet mission demands. Therefore, about 60 transports were contracted to fly trans-Pacific routes full-time. This taught the Air Force that the active forces would need the capability to meet emergencies and would have to rely on the reserves and commercial airlines for additional lift. (17:18)

Another outcome of increased airlift was the idea of combat airstrips. To go along with this new idea, the aircraft maintainers created the Rear Echelon Maintenance Combined Operation (REMCO). This essentially meant that only tactical elements and basic maintenance support would be in Korea; the rest of the support personnel were in Japan. This was done because of poor over-the-road transportation and the threat to large air units located close to the front lines. (18:158)

Airlift also became an integral part of aeromedical evacuation. Over 66,000 patients were transported by MATS to the US. (17:17) Patients were also evacuated by helicopter for the first time. The quick response of the helicopters, coupled with the MASH units, ensured that more patients survived and that air transportation played a key role in casualty evacuation. (18:136,140;24:157)

Korea also proved to be fertile ground for other logistical inventions. The Army introduced a new form of containerization called the CONEX (Container Express) which provided secure and weather-protected movement of supplies. These containers were reusable and could be put in the hold of a ship or in the bed of a 2 1/2-ton truck, carried on a semitrailer, or carried on a flatbed rail car. (24:156) This versatile shipping container became very popular during the Korean War and later.



Patient Being Evacuated by Helicopter During Korean War.

The Korean War was also the first time that host-nation support was used extensively. During this war, indigenous direct-hire and contract personnel worked in port, depot, and transportation operations. Host-nation support would grow in importance since it was successfully used during the Korean War.

The 1950s

The importance of airlift and the need for commercial airlift during contingencies surfaced during the Korean War. In the early 1950s, the Air Force began two programs to incorporate commercial airlift into the military airlift system. The first program, Civil Reserve Air Fleet (CRAF), was designed to provide additional passenger and cargo airlift when needed for a national emergency. The other program, logistics airlift (LOGAIR), was created to move spare materials between Air Materiel Command (AMC) depots and to shorten the supply pipeline and reduce stock levels of high-value items. (18:149;24:239-240)

Another major invention during this time was the 463L system. This system was centered around a rigid platform called a 463L pallet that could be stacked with cargo and then on-loaded onto aircraft using various types of materials handling equipment. (18:154)

These three innovations of the 1950s were the backbone of our defense transportation system for many years. CRAF and the 463L system are both still in use today, but LOGAIR stopped operating in 1992.

Vietnam War

The war in Vietnam is mostly remembered as a war of politics, bombings, and jet fighters. However, this was the first conflict in which the US used trained logisticians. Many significant logistics contributions came out of this period. (1:13)

As computers were beginning to have widespread uses throughout the world, the Department of Defense was one of the biggest users. In fact, the Air Force was implementing a standard base supply system that was the most advanced retail supply system in existence at the time. Jonas Blank wrote:

> Although nothing that sophisticated had ever been employed in a combat environment before, we decided to install the system, with its advanced computers, at our major bases in Vietnam. (1:17)

The advantage of this new supply system was that it was standardized—the same at every base. This meant that any trained supply clerk could easily use the new system in Vietnam. Also, a mobile computer was designed for maneuverability in the combat zone. This new system paid off when the supply warehouse at Da Nang Air Base was destroyed during the Tet Offensive. All asset records were destroyed, but the new computer automatically printed out stock replenishment requisitions. Within five days, 78% of the requisitioned stock was at Da Nang. (1:20)

Another supply innovation known as "SEA EXPRESS" or "Special Express" was designed to be an expedited form of sealift to haul munitions to Southeast Asia. Since 95% of the intertheater cargo moved by sealift, anything to speed up the process was tried. SEA EXPRESS began by using five ships dedicated to munitions movement. This proved to be very effective and eventually expanded to 19 ships. Once in Southeast Asia, the ships became floating warehouses until the munitions could be brought ashore. This special express system was used for two years and was phased out when permanent munition storage facilities and better ports were built. (1:17;18:154,169)

The war in Vietnam was also known for its constantly changing battlefronts that led to numerous tactical unit moves. Many of these moves were performed by air insertion and extraction. To accommodate this unique airlift requirement, aerial port squadrons formed mobility teams. This is the first time that certain aerial port teams were maintained in a combat-ready status. Shortly after the war ended, some aerial port squadrons established combat mobility branches, and several squadrons became Mobile Aerial Port Squadrons (MAPS). The need for combat-trained aerial port personnel was proven in the Vietnam War. (23:49,65,66)

One piece of materials handling equipment, which was often used by aerial port personnel as well as many other troops, was the forklift. But, the rough terrain, coupled with combat conditions, proved too much for commercially designed forklifts. After requests for a piece of equipment that would meet combat requirements, a 10,000-pound adverse terrain forklift was developed. This piece of equipment proved to be reliable and able to withstand harsh environments. (23:60,63) This versatile piece of equipment is a mainstay in most mobility situations—25 years after its introduction!

Another improvement in transportation, which is still in use today, was that of centralized traffic management in the Southeast Asian theater. The West Pac Transportation Offices (WTO) streamlined the control of intratheater airlift and sealift. The consolidation of the movement control eliminated much of the waste in transportation resources and set movement priorities. (18:157)

The Vietnam War also prompted some innovations in the aircraft maintenance field. The Army sent a floating aircraft maintenance facility, which was actually a converted seaplane tender, to Vietnam. The purpose of this "facility" was to provide a limited depot capability. This unique use of a "ship" by the Army served its purpose quite well since it could move from one anchorage to another. (24:221) Another innovation that helped aircraft maintainers was developed by Air Force supply personnel. This was known as a war readiness spares kit (WRSK) which was to be used for early support until a routine supply system could be established. (24:206) WRSKs (now called Readiness Spares Packages (RSPs)) are still a crucial part of all aircraft deployments.

Air Force civil engineers met critical needs during the war primarily due to the introduction of groups known as Prime BEEF and RED HORSE. Prime BEEF (Base Engineering Emerging Forces) teams "were constituted by requiring all US bases to organize their civil engineering units so teams with specific capability could be deployed to meet emergency conditions in the US or overseas." (24:224) These teams constructed hangars, water systems, sewer systems, and more.

The RED HORSE (Rapid Engineer Deployable Heavy Operations Repair Squadron, Engineer) squadrons were introduced primarily for emergency repair of bomb-damaged air bases. These civil engineering contributions to the mission are unquestionable.

There were many other logistics innovations during this war; several were refinements to innovations from previous wars. The first of these is the Red Ball Express. This spinoff of the World War II invention was used exclusively for expediting repair parts from the US to Southeast Asia by airlift. (24:200)

The second carry-over innovation was that of CONEXs and containerization. These had the same use and effectiveness as they did during the Korean War, but some advances were made to containers. The containers were larger (like semitrailers without wheels) and led to the development of containerized ships that enhanced off-loading at ports. (24:199)

The final innovative development that was an extension from previous wars was that of a new use for helicopters. The Army and Navy used their helicopters for "vertical replenishment"; i.e., aerial resupply. (24:208)

These logistics innovations in supply, transportation, maintenance, and civil engineering during the war in Vietnam are evidence of the importance logistics plays in combat. Most of these logistics innovations became logistics lessons learned and were implemented in later combat situations.

The 1970s

After the Vietnam War ended, several initiatives were introduced based on lessons learned from that war. The Army recognized the need to have equipment immediately available to deploying forces, so they developed the concept of "prepositioning." This method of prepositioning first began in Europe and was known as POMCUS (Prepositioning of Materiel Configured to Unit Sets). To ensure equipment was kept in proper working order, some humidity controlled warehouses were used and the equipment was frequently exercised. (18:186; 24:238)

One innovation that saw limited use in Vietnam was LOTS (Logistics Over the Shore) vessels. These were used to unload cargo from supply ships and to shuttle the cargo back and forth between the large supply ships and the shore. (21:35) During the 1970s, LOTS operations were studied and perfected for use in underdeveloped port areas. (18:179;21:50,53)

Related to both prepositioning and LOTS vessels was the idea of having Maritime Prepositioning Ships (MPS). This program began in the late 1970s as a method of prepositioning equipment and supplies for brigade-sized Marine Air Ground Task Forces. As with the Army POMCUS, the MPS program was designed to make necessary supplies, fuel, ammunition, food, and water immediately available to deploying forces. (18:179;24:239) As will be seen later, these prepositioned ships were one of the logistic successes during the Persian Gulf War.

Grenada (Operation URGENT FURY)

Very little has been written about the US involvement in Grenada that began on 25 October 1983. This is because it was a short operation that lasted only a couple of weeks. Nevertheless, it proved to be fertile ground for testing an aircraft load-planning system and an Army supply requisition process.

A computerized aircraft load-planning system called the Deployable Mobility Execution System (DMES) used a microcomputer to produce load plans for C-130, C-141, and C-5 aircraft. A success, this system increased airlift capability by 15% and reduced load-planning delays by over 90%. (18:178)

The Army saw successful short-term support of their forces in Grenada by using a Materiel Management Center (MMC):

> Under this concept the MMC first deploys a small element, which provides supply support by passing requisitions directly to the Defense Automatic Addressing System (as was done in Grenada). As additional aircraft space becomes available, the remainder of the MMC deploys with the necessary computer hardware to operate in a standard mode. Thus, the success of the MMC in URGENT FURY showed that responsive support for supply requisition flow is possible. (26:19)

Panama (Operation JUST CAUSE)

Operation JUST CAUSE in Panama had a beginning similar to that of Operation URGENT FURY in Grenada. US forces introduced overwhelming combat power very quickly, and the entire operation only lasted a couple of weeks. Since so many troops and their equipment were dropped into Panama so quickly, some of their supplies did not reach them in time.

Fuel was a problem for some Army units, but individual ingenuity overcame this problem. Two units came across a Texaco gas station and used a hand pump to fuel all their vehicles; this included jeeps, High Mobility Multipurpose Wheeled Vehicles (HMMWVs), five-ton trucks, and Sheridan light tanks. This entire refueling operation took 11 hours. (8:318) Another clever way that fuel was obtained was to persuade C-130 pilots to give up fuel from their tanks. (8:361)

Since the movement of troops was so intense, logisticians had to adopt some unconventional ways to move cargo. One unique method of unloading cargo pallets from a C-130 aircraft was to tie the pallet to the HMMWV and then drive the HMMWV out of the plane. (8:359) "One method used with CH-47s (helicopters) was to have the pilot tilt the helicopter, keeping its nose up and the back tires down, and move forward." (8:359)

Since most of the very early airlift was of infantry troops and artillery, few support vehicles were available in the first days of Operation JUST CAUSE. To adapt to this situation, one Army division used a Spanish-speaking Army sergeant to hire Panamanian trucks with drivers and laborers for local hauling. To keep the trucks and workers for the duration, the Army paid them a couple of dollars an hour and three Meals-Ready-to-Eat (MREs) a day—a unique but very effective logistics operation. (8:360)

The logisticians deployed to Panama during JUST CAUSE were very resourceful and adapted quickly to lack of support equipment, fuel, and supplies. The next challenge, the Persian Gulf War, would see a familiar beginning since combat troops were needed on the ground very quickly.

Persian Gulf War (Operation DESERT SHIELD/STORM)

To sum up the importance of logistics in the Gulf War, Brigadier General Charles M. Krulak, Commanding General, 2d Force Service Support Group, USMC, said:

> You can talk all you want about the air and ground campaigns, and—God bless them—those warriors did a magnificent job. I'd never begin to take anything from them. Ten years from now, however, when historians and strategists and tacticians study the Gulf War - what they will study most carefully will be the logistics. This was a war of logistics. (16:47)

This war of logistics began slowly for logisticians since General Norman Schwarzkopf decided to deploy combat forces first in order to immediately begin defending Saudi Arabia. It was decided that host-nation assets would have to be used to fill the logistical void. Major General William G. Pagonis was selected to head up the host-nation support negotiations. (22:76)

General Pagonis' experience told him that he would need as many professional logisticians as possible, as soon as possible. The Commander, US Forces Command, allowed General Pagonis to select 20 people to be his initial cadre of logisticians. (22:77) This proved to be one of the most significant actions in the early stages of deployment; without logisticians it would have been difficult to receive and provide for combat troops.

One of the innovations that made the Gulf War a success was the formation of a logistics planning organization called the "log cell." This log cell began as an ad-hoc think tank and grew into a long-term planning cell. Since the log cell was focused on longer-term planning, it remained separate from the Logistics Operations Center (LOC), which worked on current and near-term logistics issues. (3:23;21:7;22:102)

Another thing that was done to strengthen the logistics effort was to go against Army doctrine and have only one logistics

chief, General Pagonis, in the theater. Current Army doctrine requires one or more theater army area commands (TAACOMs) in a theater of operations when more than one corps is stationed in that theater. Since logistics units were not initially deployed due to the urgent need for combat troops, a TAACOM did not exist. Also, since the only logisticians in-theater were the ones that went with General Pagonis, his LOC and log cell evolved into the 22d Support Command (SUPCOM). Since the 22d SUPCOM was so successful in setting up the initial host-nation support and troop reception during Operation Desert Shield, they remained the theater logistics experts for the remainder of the war. In fact, instead of creating two independent TAACOMs during the ground war (one in King Khalid Military City and one in Dhahran), the support command's operations were split. Although this did not match Army doctrine, it left one commander in charge of the whole logistics effort and was very successful. (21:6,7;22:89)

A simple innovation that came out of the SUPCOM's LOC was that of the daily logistics situation report (SITREP). This report was simple because it could be handwritten, yet it was invaluable. It was reviewed and approved by General Pagonis every morning, and it was the only written method for external communication of SUPCOM's issues and needs. Although the SITREP is not new, it was a key communication tool that served as a common platform of communication. (4:4;22:88,185)

Another innovative form of communication used in the 22d SUPCOM was that of the 3- by 5-inch card system. Anyone in the command wishing to supply information simply filled out this card, addressed it to the commander, and indicated who sent the card. All cards were received and acted on within 24 hours.

> The use of this simple, direct method for communicating to the commander was innovative, saved time, eliminated the heaps of bureaucratic paper required in most headquarters, and conveyed a sense of urgency in command communications. (21:9)

One final form of communication used by all branches of service was that of the fax machine. Since many other forms of communication were overloaded or nonexistent in some places, the fax machine provided accurate information in both normal and secure modes in a short amount of time. (13:2)

During the early part of Operation Desert Shield when emphasis was still being placed on getting combat troops into Saudi Arabia, the first MPSs began to arrive at the port of Al Jubayl. Since logisticians were being held in lieu of combat forces, there were no support forces available to unload the MPSs. So, Marines from the 1st and 7th Marine Expeditionary Brigades became stevedores and handled their own unloading. (2:52) The needed equipment and ammunition were quickly "married up" with the Marines. Within a few weeks, the Marines, the Navy, and the Army all had cargo-handling personnel at the ports to unload nearly 95% of all the cargo for Desert Shield/Storm.

Because this was the quickest and largest sealift buildup since World War II, some have called the sea routes a "sea bridge." General Schwarzkopf said that it was "an 8,000-mile, 250-ship haze-gray bridge, one ship every 50 miles from the shores of the United States to the shores of Saudi Arabia." (28:44)

While many of the so-called lessons learned criticize the demise of United States sealift capacity, the lesson to be learned here is that the innovative MPSs worked, as did the sea bridge. The prepositioning ships, fast sealift ships, US-flag and foreign-flag merchantmen, and US government-owned ships from the Ready Reserve Forces were all brought together by experienced logisticians under the US Transportation Command (USTRANSCOM) and Military Sealift Command (MSC). "People experienced from prior live-deployment exercises (such as REFORGER in Germany and TEAM SPIRIT in Korea) were the day-saver in making this necessarily complex system responsive in a no-notice deployment." (20:43)

Once combat troops were in place and the logistics support units were established, plans were being made for offensive ground operations. Logistics would be a critical part of any offensive tactics, and General Pagonis was involved from the very beginning. He developed the idea of having movable logistical bases from his studies of military history, especially by studying Alexander the Great and German Field Marshal Rommel from World War II. He summarized his plan for the log bases as follows:

> Our "two-wheel" plan envisioned that the SUPCOM's logbases would be set up in the desert at a location no farther than one day's round-trip from the COSCOMs (Corps Support Commands) which were supporting the corps. These, in turn, would be situated less than one day's round trip from the DISCOMs (Division Support Commands), which would be providing fuel, ammunition, equipment, and supplies directly to the troops fighting at the front. (22:135)

The important thing to remember is that these were "movable" log bases—whenever the troops moved forward, so would the log bases. This idea seemed incredible at the time, yet it was carried out flawlessly. In fact, General Schwarzkopf praised the log bases:

> Not only did we move the troops out there, but we literally moved thousands and thousands of tons of fuel, of ammunition, of spare parts, of water and of food, out here into this area. . . . I can't give credit enough to the logisticians and transporters who were able to pull this off. . . . (29:171)

To aid in the establishment of log bases, Transportation Control Centers (better known as truck stops) were set up along supply routes. These truck stops provided a place for drivers to eat, take a shower, take a nap, watch a videotape, refuel their vehicles, and have their vehicles serviced. These stops were designed for morale and mission needs. The drivers needed to relax during long trips, and the vehicles needed periodic maintenance.

One morale booster that began at these truck stops and spread to many other areas was the "Wolfburger." This American-style hamburger was a big hit with truck drivers, and it eventually became popular with all the troops. "Wolfmobiles" also began to show up at various places, selling hamburgers, fries, and Cokes. This morale booster was a big success.

At about the same time that the log bases were set up, the Marines' 2d Force Service Support Group (FSSG) was given a task to set up a support facility just outside the Kuwaiti border. (This was to be used in support of the ground war.) In just two weeks of nonstop work, this new facility, named Al Khanjar, had 151 separate ammunition cells; 5,000,000 gallons of fuel; 1,000,000 gallons of water; and the Navy's third largest hospital. All of this was dug in to prevent Iraqi artillery damage. (16:56) This truly astonishing buildup was achieved by using many different forms of transportation: tactical vehicles, leased commercial tractor-trailers, Air Force C-130 aircraft, Marine CH-53 heavy-lift helicopters, and Army LCU-2000 landing craft and logistic support vessels. (2:53-54) Both the log bases and the buildup of Al Khanjar are probably the two most amazing, purely logistical feats, in the entire war.

There were several other innovations developed during this war. Again, as in earlier conflicts, some of these innovations were just derivations of previously used concepts.

The Air Force used the Central Air Forces (CENTAF) Supply Support Activity (CSSA) to channel all requirements and

requisitions to a single location, Langley Air Force Base. (13:2) To improve the requisitioning process, Desert Express/European Express was designed. This express mission was "copied" from air express companies like Federal Express and was designed to deliver extremely high-priority items such as aircraft and tank spare parts. The Desert Express mission used Charleston Air Force Base as its hub, while Rhein-Main Air Base in Germany was the hub for the European Express mission. These bases were chosen since they both share runways with international airports, making them easily accessible to other modes of transportation.

The Air Force also developed a so-called hub for C-130 aircraft engine repairs. These repairs were accomplished at Rhein-Main Air Base, which CENTAF referred to as "Queen Bee." Because there were many units of C-130s at many different locations throughout Southwest Asia, a centralized maintenance facility was needed. Rhein-Main was chosen because it was already equipped for such repairs. (6)

CENTAF also had what it called "Blue Ball Express," a spinoff of Red Ball Express from World War II and Vietnam. This was used beginning in mid-January when it was evident that C-130 support would diminish if actual fighting took place. CENTAF used all available military tractor-trailer drivers and *bought* commercial tractor-trailers, primarily to move munitions and fuel. (6) While using military drivers in civilian trucks may seem unorthodox, it was an innovative plan that worked.

When the war was over and Kuwait was free, the logisticians had to complete one more task: redeployment, which became Operation DESERT FAREWELL. The redeployment took place in two phases. The first phase was to get as many combat troops out of the theater as soon as possible. Phase II was accounting for, packaging, and shipping all equipment and supplies remaining in the theater. During World War II, Korea, and Vietnam, huge amounts of equipment were left in those theaters. "Desert Farewell was the first close-out of a theater of war by United States forces in this century." (22:156)

Somalia (Operation RESTORE HOPE)

The US sent forces to Somalia with the mission of:

> . . . securing major air and sea ports, establishing and securing ground lines of communication to major humanitarian relief centers, and providing reliable airlift in support of US military, United Nations and nongovernmental (NGO) humanitarian relief operations. (9:1)

The majority of this mission centered around the continuous airlift of humanitarian relief supplies and military logistical resupply. Since this logistics effort just ended, there is not much information yet available. However, Operation RESTORE HOPE did provide the first use of a KC-10 tanker for aeromedical evacuation. (9:3) This unique use of a dual role tanker/airlifter for aeromedical evacuation shows just how important innovations are in carrying out a difficult mission.

Conclusion

This quick review of logistics during the past 50 years shows that "innovation is the key to successful logistics support in combat." (10:34) As in past conflicts, improvising will be necessary for successful logistics support in the future. Therefore, "the professional logistician must review the lessons of the past to build a reservoir of ideas that can be the catalysts [sic] for solving tomorrow's logistics problems." (10:34)

References

1. Blank, Jonas L. "The Impact of Logistics Upon Strategy," *Air University Review*, 24 (March-April 1973), pp. 2-21.
2. Brabham, James A. "Training, Education Were the Keys," *Proceedings*, 117 (November 1991), pp. 51-54.
3. Carr, John J. "Logistics Planning for Desert Storm," *Army Logistician* (September-October 1991), pp. 23-25.
4. Carr, "Starting from Scratch in Saudi Arabia," *Army Logistician* (January-February 1993), pp. 2-7.
5. Cragg, Dan. "The U.S. Army in Grenada," *Army* (December 1983), pp. 29-31.
6. Dahl, Linda J., Chief of Plans and Programs (CENTAF/LGT) during Operations Desert Shield and Storm, personal interview, 30 April 1993.
7. "Desert Storm: Unleashing the Might of Materials Handling," *Modern Materials Handling* (4 July 1991), pp. 50-67.
8. Donnelly, Thomas, and others. *Operation Just Cause - The Storming of Panama*, New York NY: Lexington Books, 1991.
9. Evans, Walter S. "Operation RESTORE HOPE After Action Report," report to HQ AMC/CC/XO/QS, HQ AMC TACC/CC, HQ 21 AF/CC/DO, HQ 22 AF/CC/DO, HQ 15 AF/CC/DO, 7 April 1993.
10. Flanagan, William J. "Korean War Logistics: The First Hundred Days," *Army Logistician*, 18 (March-April 1986), pp. 34-38.
11. Green, Bill, and others. "Two Steps Ahead," *Proceedings*, 117 (May 1991), pp. 97-99.
12. "Grenada: Special Report," *Airman* (February 1984), pp. 37-42.
13. Hagel, Stephen J. "Capturing Logistics Data," *Air Force Journal of Logistics*, 16 (Winter 1992), pp. 1-9.
14. Hogg, James R. "Judging Our Success," *Proceedings*, 117 (May 1991), p. 100.
15. Joint Logistics Review Board. *Logistics Support in the Vietnam Era - Volume 1: A Summary Assessment with Major Findings and Recommendations*, 1970.
16. Krulak, Charles C. "A War of Logistics," *Proceedings*, 117 (November 1991), pp. 55-57.
17. Launius, Roger D. "Korean War Airlift," *Airlift*, 12 (Summer 1990), pp. 16-21.
18. *The Logistics of Waging War: American Military Logistics 1774-1985, Emphasizing the Development of Airpower*, Air Force Logistics Management Center, Gunter AFS AL, 1985.
19. May, Gary B. *The Impact of Materials Handling Equipment on Airlift Capabilities*, Research Report No. AU-ARI-83-7, Maxwell AFB AL: Air University Press, August 1983.
20. Norton, Douglas M. "Sealift: Keystone of Support," *Proceedings*, 117 (May 1991), pp. 42-49.
21. Pagonis, William G., and Krause, Michael D. "Observations on Gulf War Logistics," *Army Logistician* (September-October 1992), pp. 5-11.
22. Pagonis, *Moving Mountains - Lessons in Leadership and Logistics from the Gulf War*, Boston MA: Harvard Business School Press, 1992.
23. Parker, David J. *Aerial Ports in Low Intensity Conflict: Vietnam, Grenada, and Panama*, MS thesis, AFIT, GLM/LSM/90S-43, School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1990 (AD-A 229464).
24. Peppers, Jerome G., Jr. *History of United States Military Logistics: 1935-1985 - A Brief Review*, School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 1987.
25. Porreca, Bob. "Truckstop in the Desert," *Army Logistician* (September-October 1991), pp. 12-13.
26. Radin, Robert M., and Bell, Raymond A. "Combat Service Support of URGENT FURY," *Army Logistician* (November-December 1984), pp. 16-19.
27. Record, Jeffrey. "On the Lessons of Military History," *Military Review*, 65 (August 1985), pp. 27-39.
28. Schwarzkopf, Norman. "A Tribute to the Navy-Marine Corps Team," excerpts from his 29 May address to the 1991 graduating class of the Naval Academy, *Proceedings*, 118 (August 1991), p. 44.
29. Watson, Bruce W. *Military Lessons of the Gulf War*, Chapter 11: Logistics Lessons by Joel H. Nadel, Presidio CA: Presidio Press, 1991.

Captain Lee wrote this paper while attending the School of Systems and Logistics, AFIT, Wright-Patterson AFB, Ohio. She is presently Transportation Staff Officer, Transportation Division, Air Force Materiel Command/LGT, Wright-Patterson AFB, Ohio.

Current Research

Air Force Logistics Management Agency (AFLMA) FY94 Program

Annually, AFLMA contributes to this portion of the Journal. Our last contribution appeared in the Summer 1992 edition. Many of the projects in that listing have been completed, and we sincerely hope the Air Force logistics community is more effective because of them.

Cooperative efforts outside the Agency have been outstanding. Personnel from MAJCOMs and bases have helped by providing "real world" data, test-bed sites, survey participants, "sounding boards" for new approaches, and key recommendations on better ways to solve logistics problems.

Below are our in-work top projects for FY94. If you are interested in any of these projects, please contact the project officer. If commercial lines are used, dial Area Code (205) 416-plus the last four digits of the DSN number.

Maintenance and Munitions

Maintenance Management Handbook, LM930352

Objective: Provide a guide for maintenance managers at the squadron officer and senior NCO level, and for both flightline and backshop users. The guide will incorporate changes over the past several years that affect flightline and backshop maintenance organizations.

Capt Lyndon Anderson or Capt Michael Labosky, AFLMA/LGM, DSN 596-4581

Aircraft DLR Flying Hour Lessons Learned, LM931581

Objectives: (1) Compare, across MAJCOMs, Depot Level Reparable (DLR) cost per flying hour for same weapon systems and establish reasons for differences. (2) Determine feasibility of establishing a standard cost per flying hour for each mission design and series (MDS).

Capt Lois Schloz, AFLMA/LGM, DSN 596-4581

Feasibility Study on the Use of Alternative Surface Finishes for Military Aircraft, LM922167

Objective: Determine if polyester or polyurethane films have a potential for use on military aircraft. This project will track a commercial airline's test of the materials and also develop a total cost analysis of the C-141 paint/depaint process and compare it to a projection of using aircraft film.

Capt Edward Stalker, AFLMA/LGM, DSN 596-4581

Quality Assurance Tracking and Trend Analysis System (QANTTAS), LM930601

Objective: Revise the current QANTTAS software program (version 2.2) to reflect the changes identified by the MAJCOMs (HQ ACC, HQ USAFE, HQ PACAF, ANG, and AFRES) to meet the needs of base-level quality assurance programs.

Capt Dee Jay Jackson, AFLMA/LGM, DSN 596-4581

Logistics Plans

Logistics Group Commander's Organizational Assessment Tools, LX930481

Objective: Provide a guide which covers the key indicators and enhances the problem identification and resolution capabilities of logistics group commanders. This guide book is being developed to answer a request by members of the Logistics Group Commanders Course, Class 93-B, who asked for a "Tool Box" that would help them assess the health of each squadron in their group.

Maj Margaret Curran, AFLMA/LGX, DSN 596-3535

International Support Agreements Guidebook, LX932252

Objectives: (1) Publish a guide that describes international agreement development, negotiation, and conclusion procedures. (2) Provide a suggested standard format for international logistics support agreements.

Maj Margaret Curran, AFLMA/LGX, DSN 596-3535

Collocated Operating Base (COB) Assessment Program, LX933531

Objectives: (1) Develop PACAF automated capability assessment program/software that is user-friendly, menu-driven, and IBM compatible. (2) Implement program at the 51st Collocated Operating Base Support Squadron (COBSS), Republic of Korea, and evaluate and modify the program as required.

Maj Mark Wnuk, AFLMA/LGX, DSN 596-3535

Feasibility and Impact of Standard Packages of WRM Support (STOWS), LX932891

Objectives: (1) Assess feasibility of STOWS by examining proposed concepts as well as similar procedures used by other commands or services, past, present, and proposed. (2) Address present and possible future impact STOWS, or other recommended concepts, will have on forces deploying to USAFE that are beyond case two levels. (3) Provide data for other MAJCOMs to assess the feasibility and applicability for implementation.

Capt Janice Irving, AFLMA/LGX, DSN 596-3535

Automated Mobility Processing System (AMPS), LX932501

Objectives: (1) Modify AMPS to interface with Modernized LOGMOD-B, CMOS, and MANPER-B. (2) Successfully test AMPS in conjunction with those systems, both in the laboratory and in the field. (3) Field an AMPS prototype and make it available for use Air Force wide. (4) Transfer AMPS functionality to existing standard systems or, if required, transition those portions of AMPS that do not fit a current standard into a separate standard system.

Capt Jay Jennings, AFLMA/LGX, DSN 596-3535

Contracting

Contracting Squadron Commander Handbook, LC932893

Objectives: (1) Revise the Base Contracting Officer Handbook to incorporate changes brought about through activation of contracting squadrons and overall changes in the field. (2) Provide a reference for commanders on the daily operation of a contracting squadron, which includes suggestions/recommendations on how to manage squadron workload, personnel, and resources, and how to introduce new concepts such as Total Quality Air Force. (3) Provide a guide to situational management and leadership. (4) Provide commanders with a reference guide during the first critical months of command to help reduce management errors caused by lack of experience. This handbook will be designed for use by SAF/AQCO in teaching the Contracting Squadron Commanders Course and also will serve as a technical reference for squadron commanders on a daily basis.

Capt John Perry, AFLMA/LGC, DSN 596-4085

Contingency Contracting Deliberate Planning Handbook

Objective: Develop a guide for operational contracting squadrons to prepare for contingency deployments. The guide will be a compilation of previous research efforts as well as current initiatives. Topics will include (1) review of operations plans to determine tasking requirements; (2) determination of what resources will be needed for taskings; (3) geographic, cultural, and other factors influencing resources; (4) Exercise and Operational Readiness Inspections; and (5) Contingency Contracting Officer Training Plans. This guide will be designed for use by all agencies with possible contingency missions and will provide the basis for base-level preparation.

Capt Tom Snyder, AFLMA/LGC, DSN 596-4085

Supply

Systemic Review of the Combat Supplies Management System (CSMS), LS930151

Objectives: (1) Validate the CSMS requirement and recommend improvements to the current system. (2) Investigate system problems to determine whether they are system or user induced, and try to resolve those problems identified through this study. (3) Provide a source of CSMS information describing key processes, interfaces with other systems, responsibilities, helpful hints, potential pitfalls, and interpretation of product outputs.

Capt Raymond Daly, Jr., AFLMA/LGS, DSN 596-4165

RSP Review Cycle, LS930082

Objectives: (1) Provide MAJCOM and Air Logistics Center readiness spares package (RSP) managers with a source of information which describes the entire process of building and fielding RSPs. (2) Identify how the system is supposed to work and document how it is currently working. (3) Recommend changes to reduce the amount of time it takes to perform an RSP review. (4) Suggest ways to standardize the methods of building electronic countermeasures (ECM) kits, determining in-place readiness spares package (IRSP) offsets, and building consumable segments of RSPs.

Maj Timothy Ondracek, AFLMA/LGX, DSN 596-4165

USAF Weapons/COMSEC Serialized Reporting, LS922175

Objectives: Analyze the current processes used to manage communications security (COMSEC) items/weapons by serial number, identify problem areas, and provide recommended process and systems changes. Current management procedures and practices, as well as computer interfaces, for serial-number control items appear to be ineffective in providing positive control to ensure return of issued items, prevent loss of accountability, and provide accurate reporting to central DOD control points.

Capt Marcus Hogins, AFLMA/LGS, DSN 596-4165

Analysis of Airlift Investment Policy, LS930051

Objectives: (1) Describe current procedures/policies for assigning and deleting airlift investment codes. (2) Weigh the costs and benefits associated with the current definition of airlift investment codes. (3) Explore alternative definitions/procedures and weigh their costs and benefits.

Capt James Johnson, AFLMA/LGS, DSN 596-4165

Communications-Electronics ISSL Regionalization, LS922152

Objectives: (1) Develop a regionalized stockage policy for fixed C-E Initial Spares Support Lists (ISSL). (2) Identify the criteria to determine which items to regionalize. (3) Determine associated costs and operational impacts.

Steve Cain, AFLMA/LGS, DSN 596-4165

Transportation

Replace the -2 Plus Computer Program, LT932181

Objective: Provide the user with an easy-to-use, comprehensive microcomputer program that accommodates the Shipper's Declaration for Dangerous Goods Form.

Capt Jim Toler, AFLMA/LGT, DSN 596-4464

Transportation Managers Handbook, LT932291

Objective: Develop an easy-to-use, comprehensive, and current Transportation Managers Handbook. The book will update organizational realignment and describe new automated systems.

Maj Eric Williams, AFLMA/LGT, DSN 596-4464

Automated Fleet Information System (AFIS) to Ada Conversion, LT932081

Objective: Write the four base-level modules and MAJCOM module in DOD standard Ada language. AFIS is currently written in the Clipper programming language. This conversion will make it a standard system.

MSgt Kathy Thompson, AFLMA/LGT, DSN 596-4464

Automate the DD Form 1149, LT943021

Objectives: (1) Provide a diskette interface between the shipper's DD Form 1149 data and cargo movement operation system (CMOS). (2) Develop a program to allow the shipper to enter data which can be transferred onto a floppy diskette and taken to the traffic management office (TMO).

Capt Jim Toler, AFLMA/LGT, DSN 596-4464

History of Containerization Within the Military

Captain Robert A. Moriarty, USAF
Captain Rudolph E. Turco, USAF

Introduction

Today's military environment is one in which speed and distance take on tremendous importance. This is true now more than ever before. All branches of the Department of Defense (DOD) must be able to move faster and further than at any other time in history to achieve national policy and military objectives. With this need for increased speed and projection of power comes an even greater requirement for logistical support of the troops and equipment in the theater of operations. There are literally thousands of supply and munitions items which must accompany the soldier, airman, marine, and sailor to battle to ensure complete effectiveness. (1:1) The distribution system must supply and resupply these troops without interruption or the battle will be lost, along with countless military members and critical equipment.

Containerization, in conjunction with intermodal shipping, may be the key to successfully resupplying the troops in today's military. Desert Storm may be the new model for containerization and intermodal shipping of war materials. It was the first war which routinely relied upon the benefits of containerization and intermodal shipping in a significant and systematic way.

Historical Background

Containerization is not a new concept; in fact, the principles were first recorded in 1801 by Englishman Dr James Anderson. (2:30;3:2) Practical examples of containerization can be found as early as 1834 when the state of Pennsylvania began shipping containers by using a combination of canal barges and rail. (3:2) Railroads started using containers in the United States as early as 1921 when the New York Central and Pennsylvania Railroads included containerized freight on their runs. (4:15;5:31) In Great Britain, a combination of rail and motor freight was used to deliver containerized cargo as early as 1926. (6:15)

During this time frame, as containerization began to expand and its economic benefits recognized, the concept came under fire. In 1931, the United States Interstate Commerce Commission ruled that containerized freight rate structures for railroads were too low. As a result, rates rose significantly and usage of containerized freight and intermodal connections declined precipitously. (4:15) Finally, in January of 1955, Malcomb McLean, owner of McLean Industries, purchased the Pan-Atlantic Steamship Corporation. Later that year, on 27 April 1956, the company began the first regularly scheduled container service. From this humble beginning, Sea-Land Service, an international intermodal container freight shipping company, was born. (7:32-33) Soon thereafter, the remaining modes of transportation—rail, motor, and air—began to implement containerized shipping methods and procedures.

One of the primary reasons for the growth in containerization and intermodal shipping stems from the economies of handling freight only one time. Additionally, intermodal freight and containerization allow the shipper to make use of the inherent advantages of each mode (motor, rail, water, air) of transportation. The graph contained in Figure 1 helps explain the economies of three modes. The vertical axis represents fixed costs associated with the various modes of transportation. As the graph shows, water and rail are characterized by high fixed costs while motor freight has fairly low fixed costs. However, water and rail are also characterized by very low variable costs. Over distance, the effects of the high fixed costs are absorbed or reduced due to the low variable costs associated with water and rail transportation. Trucking is characterized by higher variable costs. As the graph indicates, each mode is the low cost transporter for a certain range of distances. Trucking is initially the low cost transporter; then rail; and then, for very long distances, water shipments. Intermodal shipping allows the shipper of goods to take advantage of the lower costs associated with rail and water and still have the flexibility of door-to-door deliveries associated with trucking. Air freight, not pictured on the graph, is characterized by very high variable costs and would be used primarily for high priority shipments of sensitive cargo. (8:135)

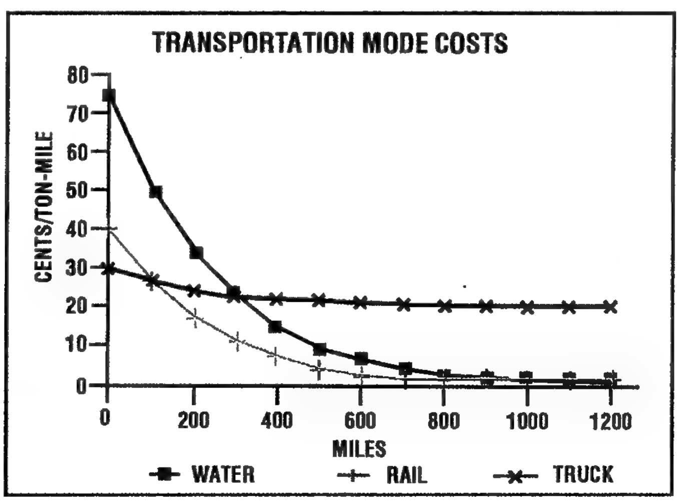


Figure 1. Mode Costs of Transportation.

The military also recognized the potential benefits and, as a result, began its formal efforts with containerization as early as 1947. During this time, the US Army began experimenting with small containers meant to "combine, transport, and protect small package shipments while in transport." (9:33) Some of these containers were used in Korea. (4:15) The combined effects of the earlier experiments and use of containers in Korea led to the initial development and deployment of the Container Express (CONEX) system. (4:15-16; 10:33) This system, which was a fore-

runner of commercial containers, quickly caught on and the number of CONEXs grew from 80,000 in 1953 to over 200,000 by 1971.

After the introduction of the CONEX during the 1960s and 1970s, the military and commercial enterprises went in separate directions. With the advent of specific international standards for containers and the decision by most of the intermodal freight shippers to conform to those standards, the military's CONEX began to lose ground to commercial container versions. (10:39-66;11:18) Smaller Merchant Marine forces and the military's growing reliance on both domestic and foreign sealift sources began to force the US military to find ways to conform to current commercial and International Organization for Standards (ISO) and their methods of operation. (11:18) In the early 1970s, the US military began to field its own container, MILVAN, which conformed to all ISO standards. (12:5) In addition to the MILVAN, the US military currently relies heavily on commercial contract-supplied ISO containers to meet its intermodal shipping requirements. (13:146)

Terms and Definitions

The subject of containerization is filled with related terms, definitions, components, and concepts. The following paragraphs will briefly review some of the key concepts and definitions concerning containerization:

The term *breakbulk* describes a procedure where each piece of freight is lifted individually into the cargo hold of a ship. This was the traditional method of moving goods over sea routes prior to containerization. For instance, virtually all of the cargo and supplies sent to units in World War II were in the form of breakbulk. In Korea, the CONEX made its debut but was itself loaded as breakbulk; i.e., it was not loaded into a container ship. (9:33;14:636) In Vietnam, during calendar year 1968, 82% of the supplies and cargo shipped from the US were in the form of breakbulk, while the remaining 18% were shipped in CONEXs or other intermodal containers. (15:2-42) Finally, Desert Storm saw 28.8% of the sustainment cargo and unit supplies shipped in the form of containerized freight. (1:3) The military currently ships about 80% of its peacetime supplies overseas using containers. (16:3;17:3) Commercial freight shippers containerize close to 90% of their cargo. (18:4) The breakbulk method of shipping requires more lifts than when using containers and is therefore considered less efficient. (18:4)

Intermodal transportation is a process which allows a shipper to move freight to various locations using any combination of the four primary modes: water, railroad, motor or truck, and air. (5:33) Intermodal transportation increases efficiency by allowing a single carrier to "manage the documentation and movement of cargo" as it is transported via the different modes. (1:4) Additionally, it allows door-to-door service without having to load or unload the contents of the container each time it is transferred between the various modes. (18:42) The concept of intermodal transportation allows the shipper to exploit the economies of each of the modes of transportation as discussed earlier.

A *container* is "an enclosed, permanent, useable, non-disposable, weather-tight shipping conveyance, fitted with at least one door and capable of being handled and transported by existing equipment and modes of land, air, and sea transport." (19:7) Containers allow fewer lifts while loading onto sea-going vessels. Additionally, they eliminate the need to handle the contents of the containers at the intermediate points within the transportation system. In general, the trend over the past four or five decades, for both military and commercial shipping, has been to ship more and more material in containers and less and less using traditional breakbulk methods. As mentioned earlier, over 80% of all peacetime, export cargo, including DOD-owned cargo, is currently shipped in containers. (16:3;17:3; 20:31-32)

Stripping is the process of taking material out of the container. (21:F-25) Stripping operations require a reasonable amount of room. Sometimes after being stripped, cargo must be routed to various units or organizations, thus requiring space for vehicles to be loaded and cargo to be segregated and then reloaded into either a different container or truck.

Stuffing is the opposite of stripping; that is, it is the process of loading a container. It includes several components such as packing to the proper level of protection, unitizing the cargo, selecting the right container, and placing heavy items at the bottom. (21:25)

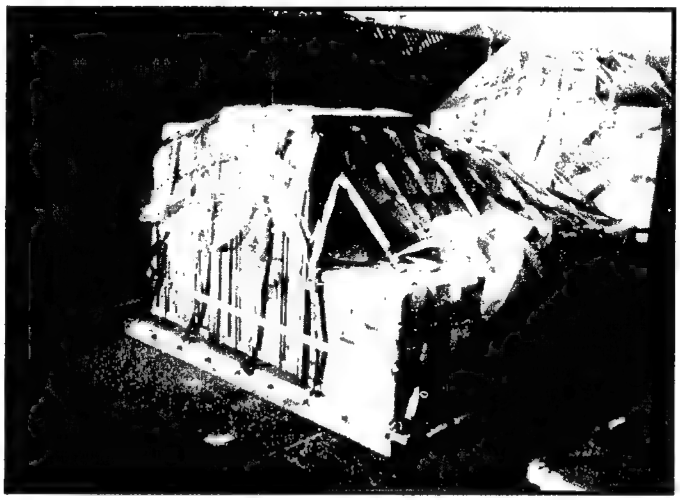
Land bridge is a concept where cargo would move from a land origin to sea transport and back to a land destination. (22:31) A secondary concept, referred to as both land bridge, or minibridge, is where intermodal freight can be transported by sea to a seaport on one side of the country, such as New York, and then linked to a seaport on the other side of the country, such as California, via rail or motor service. (23:6) The cargo then continues its journey via sea vessel. Usually, the mode of transportation between seaports is rail, due to its inherent economies. Several US rail companies have dedicated runs between seaports, cutting the cross-country port-to-port delivery time to less than four days. (5:33) The development of the land bridge has increased, and it will continue to enrich the effectiveness of military and commercial logistics operations. Containerization and intermodal freight transfers have been the key to making land bridges economically possible.

The *463L pallet*, developed in 1957 to ensure efficient use of military airlift, is a type of cargo unitization system used for the vast majority of air cargo within the military. (24:13;25:36) Currently, there are about 150,000 pallets within the DOD inventory. (26:7) The 463L pallet does not have hard sides; therefore, the cargo is stacked on the pallet and then constrained by use of cargo nets and straps. Pallets have certain advantages over containers. Specifically, they cost and weigh less (400 pounds per pallet) and can be stacked for reshipment back to the US during a contingency. (27:58) Currently, the 463L pallet is

the primary system used for shipping military air freight. Several commercial air freight companies use containers because of their efficiencies rather than pallets, but these containers are unique and many times do not meet ISO intermodal container standards. (26:6) Because of the reluctance of the military and commercial air freight companies to ship ISO containers, and DOD's lack of a lightweight container which can be mated with the 463L pallet system, air freight is probably the least compatible mode within intermodal container transport systems. (13:1,56) Nonetheless, the 463L cargo pallet system performed well during Desert Storm. After unloading the pallet from the aircraft, it could then be placed on a 2 1/2-ton truck, or 40-foot flatbed trailer, making delivery of air freight possible virtually anywhere within the theater of operations. (25:36-37)

Innovations

As time passed, several developments were initiated which allowed even greater use of containerized freight. This is an important concept because the vast majority of commercial freight has gradually transitioned from breakbulk to containerization. The military was among the earlier pioneers in creating innovative systems to take advantage of containerization.



The CONEX was the military's first effort at containerization. Testing for the containerization system, which eventually became the CONEX, began in 1947. By 1953, the system had been developed and was fielded. (9:33-34) The CONEX was used on a limited basis in Korea and extensively in Vietnam and in the years between. (9:34;26:5) The CONEX was a heavy metal box measuring 8′6″ x 6′3″ x 6′10 1/2″. It had an interior volume of 295 cubic feet and could hold 4 1/2 tons. By the end of 1968, there were nearly 200,000 CONEXs in existence. (15, Sec 2, 19-20)

The MILVAN, which entered the DOD inventory in 1978, is a container which can handle up to 20 tons of general cargo. The MILVAN represents the military's most recent effort in terms of procuring its own containers. It is 8′ x 8′ x 20′ and weighs 4,770 pounds. It has an internal volume of 1,060 cubic feet and is designed to meet the requirements of the American National Standards Institute/International Organization for Standards. The MILVAN was never produced in quantities even approaching that of the CONEX, although it was initially intended to take the place of the aging CONEX. In fact, only about 2,200 have been procured thus far. (12:5)

There are several other types of containers which have been developed during the past few decades as requirements and needs changed: open-top containers for heavy equipment; refrigerated containers for food, drugs, and chemicals; heated containers to protect commodities from cold weather; ventilated containers to help avoid accumulations of humidity; tank containers for liquids; gondola containers for bulk materials; automobile-carrying containers; and even livestock carrier containers. (6:18-19)

In addition to these developments, there have been many innovations regarding how containerized freight is handled. In the Logistics-Over-The-Shore (LOTS) system, supplies, cargo, equipment, or containers are off-loaded from the cargo ship without the use of docks. The LOTS process loads the cargo onto shallow draft barges or hover craft which then transport the cargo to the shore. During Vietnam, LOTS operations were difficult because of the poor condition of the necessary equipment. (15:4-32) Today's main concern is even more significant. Specifically, containers represent a heavy lift requirement. Many of today's container ships are not self-sustaining; that is, they do not have the capability to off-load themselves. (24:13) Ports which are capable of unloading container ships will be the target of enemy actions. If these enemy actions are successful, containerized logistics movements will suffer. Many systems have been developed to help improve LOTS operations with regard to containerized freight.

One of the primary means of carrying out LOTS operations is with the Lighter Aboard Ship (LASH). Basically, this is a large ship which carries lighters, or barges, which are 61′6″ x 31′2″. These lighters can be lifted on and off the LASH. The lighters are used to carry containers and link the LASH with interior waterways. This allows delivery of containers holding supplies at points other than seaports. (28:35)

The Seabee is another type of barge carrier which can be used in LOTS operations. The primary difference between the Seabee and the LASH is that the barges are much larger and can hold more containers. Additionally, the loading system on the Seabee allows two barges to be loaded or unloaded at the same time. (28:35)

Rollon/Rolloff (RO/RO) vessels are designed to support heavy, wheeled equipment. These vessels are loaded by having the cargo driven onto the ship by use of ramps connecting the ship to the dock and are unloaded in the opposite manner. (28:35) This type of ship can loosely be considered to be holding containerized freight; however, the concept of operations is different. This type of ship is normally used for rapid deployment in the early stages of a conflict. (18:24)

One of the most unique LOTS methods began in 1972 when the US military started tests which involved lifting containers off ships using large helium-filled balloons. Specifically, 125-foot-high, 200,000-cubic-foot balloons would lift the container out of the ship and then through a system of cables and winches, and either load the container onto a barge or transport it up to 2,000 feet to a staging area on shore. Tests showed that the balloon could be repaired after sustaining significant damage from rifle fire or tears in the balloon fabric in as little as 15 minutes. Although the system was not added to the US military's inventory, it was considered a viable, potential system for future acquisition. (29:1-4)

A high-tech LOTS innovation is the Lighter, Air Cushion Vehicle, 30 Ton (LACV-30). This lighter, or barge, actually rides on a cushion of air and can transport two 20-foot or one 40-foot container at speeds up to 62 mph. It can also carry

wheeled and track vehicles and a variety of other cargo although it was designed primarily as a container transport. As of 1991, the Army had fielded 24 LACV-30s in two companies, each of which is capable of transporting 400 containers per day during a LOTS operation. (12:101;30:19)

Innovations in LOTS operations have not been the only way to improve off-loading of containerized freight. For instance, an interesting and effective way to off-load containers can be found in something called the elevated causeway. This system can be constructed in 96 hours and provides two-way traffic capability from the shore to the container ship, allowing container handling equipment (CHE) to carry the container to land. A similar innovation is the powered causeway which has two diesel-driven, water-jet engines. This type of causeway acts as a ferry to move containers and cargo from the ship to the shore. (17:18-19)

Once the cargo is off-loaded from a container ship, it must still be moved and positioned for the overland portion of its journey. Several innovations in materials handling equipment (MHE) and container handling equipment have been made over the years. Traditionally, containers have been off-loaded from the container ship by use of pier-mounted gantry cranes. Now, in addition to pier-mounted cranes, the Navy has developed ship-mounted gantry cranes capable of lifting containers. Ship-mounted cranes have been in use for many years but have become bigger and more capable in terms of heavy lift capacity as a result of the current trends toward containerization and using the larger 40-foot containers. Unfortunately, these ship-mounted cranes can only be used when sea conditions are calm. (19:41;6:49-50)

Once the container is off-loaded from the ship, it must be positioned or moved away from the pier or dock. There are several types of equipment that have been developed for this part of the operation. The most common piece of equipment, which has been in existence for a number of years, is the forklift. Nonetheless, forklifts have grown in capacity and are now capable of lifting up to 50,000 pounds. The 50,000-pound, rough terrain container handler, capable of lifting a 20′ x 8′ x 8′ ISO container, is now a key piece of equipment required to download and position these containers in forward areas. (1:38) In addition to forklifts, there are carriers which literally straddle the container, lift it, and then transport it to its destination. Another piece of equipment, the spreader, is used to keep containers level during loading and unloading operations. Spreaders are used with either cranes or forklifts. Other types of container handling equipment can lift the container from either the side or the top. All of these pieces of equipment have been specially designed over the years to handle the unique characteristics of containers. (6:51-52)

Many of the containerization innovations were concerned with better utilization of the container ship itself and the need to load outsized cargo. For instance, seasheds are large open-topped containers which take up the same amount of room as three 10′ x 40′ containers. A seashed can hold outsized cargo such as helicopters and tanks. (12:89) The primary purpose of a seashed is to increase the flexibility of containerships, especially since these ships make up the bulk of the sealift capability of the US and the world.

A second system for loading outsized cargo is the flatrack. A flatrack is essentially a container without sides. By eliminating the sides of the container, 6 inches of overhang on each side can be used. This allows many outsized items, such as 2 1/2-ton and 5-ton trucks which will not fit into a conventional container, to be loaded onto the container ship without loss of cargo space. (31:8-9) A 1971 study conducted by the Military Traffic Management Command (MTMC) suggested that "average ship tonnage and the required number of sailings and ships decreased due to better ship utilization and faster turnaround time." (13:33-34) Again, the purpose of the flatrack is to increase the flexibility and utilization of container ships.

Another example of an innovation which increases the utilization of containerized freight is the half container. This container is only half as high as the normal 8-foot-high container and is especially useful with high-density cargo. For instance, munitions will usually maximize the weight limitations for a normal container long before they maximize the volume limitations. The half container enables the available container volume to be fully utilized. As with regular containers, the half container can be stacked to maximize the interior hull space within a container ship. (32:12)

Because many of the larger containers are very difficult to handle in intermodal freight systems, especially the air freight mode, an innovation called the QUADCON container was developed as a potential solution. With dimensions of only 8′ x 8′ x 5′, it is literally half the size of the smallest container. Additionally, it can be mated with a 463L pallet, making it acceptable for military air transportation. (33:11-12)

Some of the advancements centered around containerization are really more or less unique ways of using containers. For instance, one very interesting innovation, suggested in 1967, was the Military All-Purpose Container and Transport (MAPCAT). This system would have improved the CONEX system by increasing its capacity by mating the container directly to a 5-ton truck. In addition, doors were installed on both the end and top of the container for easier access. Some of its unique features included a complete floatation device which would have allowed the container to be pushed or pulled up inland waterways, to withstand parachute landings, to be airdropped from low altitudes, and to be carried by special helicopters. (34:58-60) One of the primary uses envisioned for the MAPCAT was that it could be ferried to shore in Vietnam, thus reducing port congestion. Although not developed in its entirety, many of the features of the MAPCAT system were incorporated into other Army projects.

In 1972, the Navy began exploring the use of containers as mobile avionics repair shops. The use of ISO containers for avionics shops does not center around the economics of intermodalism or in maximizing cargo shipped within the container. Instead, these shops can be preestablished and delivered for shipboard use where and when needed to meet the needs of technicians repairing Navy aircraft. Each ISO container is developed with unique support equipment and supplies so aircraft carriers can be quickly converted to support specific aircraft platforms such as the A-6, F-14, or F-18. (35:1-1;13:68)

In 1974, the Navy suggested using ISO containers, which would be molded together to create a 60-bed Mobile Medical Facility (MMF). The facilities would cost less than a traditional MMF and would be extremely mobile, requiring little teardown and setup. (36) As of 1989, plans were in place for development of 23 hospitals, each requiring 400 containers. The final requirements for the program totaled 9,200 ISO containers. (13:67)

A unique innovation on the use of ISO containers came from the Marine Corps. Between 1977 and 1980, they developed a fully functional field kitchen which was made by linking between one and three 8′ x 8′ x 20′ ISO containers together. The containerized kitchen could serve three hot meals per day to between 200 and 1,000 men depending upon whether one, two,

or three containers were used. All necessary cooking equipment was maintained in the containers so they could be quickly deployed as necessary. (37)

One of the more interesting container concepts was tested in 1982. This system, called Arapaho, consists of a "portable, modular aviation facility that is compatible with modern container-type ships." (17:24) This system is self-contained and is designed to "provide mission coverage in areas such as sea-lane defense, convoy escort, mine warfare, helicopter basing, search and rescue, close air support, and evacuation." (17:24) Additionally, the system can be loaded, set up, and operating on any one of nearly 200 modern container ships in 12 to 24 hours. Even with this system in place, close to 75% of the containership's normal cargo capacity is left intact. (17:24)

Benefits

Commercial and military managers and leaders began to see the benefits of containerization nearly two centuries ago. Limited forms of containerization were used in the European theater of World War II. (22:29;10:33) These experiences, coupled with the initial development and deployment of the CONEX system, helped identify many of the benefits associated with containerization. It has been widely recognized for many years that containerization is a powerful tool for delivering commodities door-to-door while taking advantage of the economies of the various modes of transportation. Additionally, containerization results in lower freight rates, lower handling costs, lower in-transit insurance costs, reduction of product damage in transit, reduction or elimination of pilferage during shipment, reduction of traffic problems, and reduction of warehouse problems. (2:29) In 1969, a report on the potential benefits of containerization suggested that:

> The use of containerships permits ship loading/unloading time savings of approximately 80 percent. In turn, because ship time in port is so low, the productivity of the containership can be as much as 70 percent greater than that of its breakbulk counterpart on trade routes where traffic is heavy. (43:1)

A good example of the time savings gained by using containers is provided by Federal Express. They suggest that a container can be stuffed in one-quarter of the time of a comparable pallet. (26:6) The military also recognized the advantages of faster turn times for sea vessels using containers. This was an exciting concept for military planners because it increased sealift capacity without the requirement of purchasing a fleet of new cargo vessels. (38:51) On a similar note, with the decline of the Merchant Marine from 2,114 ships in 1947 to only 397 ships in 1990, significant quantities of cargo can still be carried despite fewer available US flag vessels. For instance, container ships offer better utilization, or space efficiency; and, on average, each container ship has replaced six breakbulk ships. (18:19-21,43)

Problems

Many of the problems associated with containerization have been overcome to various degrees over time, although some problems continue to worry military planners and logisticians. One of the first problems noted with containers was during the Vietnam War and dealt specifically with accountability of the CONEX containers. Units which received cargo in the CONEX did not own the CONEX itself. As a result, they were less than willing to expend the time to return the CONEX to the appropriate transportation agencies who were responsible and accountable for it. (26:12-13;16, Sec 5, 21-22,53) Additionally, the CONEX was used for a variety of functions other than transportation of materials. For instance, General Frank Besson, Commander, Army Materiel Command, points out that CONEXs, in addition to providing transport and storage for materials, were used as command posts, aid stations in combat zones, mess halls, Post Exchanges, and a myriad of other things. (39:18-26) In many cases, these highly valued structures were simply not returned to the owning agency because of their usefulness.

Another problem with containerized freight centers around the number of differing destinations for the cargo. For most modes, and the majority of cargo, that is not a problem. However, for military airlift, the number of destinations and the method of delivery can create problems. Traditionally, the Military Airlift Command (now Air Mobility Command) used a direct route, or channel flight approach, to air freight delivery, unlike hub-and-spoke delivery systems used by commercial air freight companies. With a channel flight approach, it is not uncommon for there to be too little freight for a single destination to fill a container. The net results are that the containers are not efficiently utilized. (26:6-7)

Yet another problem associated with containerization is where to perform stuffing and stripping operations. It is inefficient to use pier space to strip (or stuff) a container. Still, the logistician does not really want to allow the cargo to go very far before checking it and, if necessary, stripping the container. For example, during Desert Storm, many containers held mixed loads. Specifically, the cargo in the container belonged to more than one unit. As a result, the cargo had to be stripped at either a predesignated point, or the entire container would be sent to the unit with the greatest amount of cargo in the container. Stripping operations, conducted in an appropriate, safe environment, may help improve the efficiency of the operations. Nonetheless, during contingencies, there may not be a safe place to conduct stripping operations. Inadequate stripping and stuffing locations contribute to port congestion and would have a negative impact on ensuring troops in the field are getting the supplies they really need.

Port congestion is another problem for containerization. This problem is not caused by containerization per se. To the contrary, containterization reduces congestion at major ports during a contingency. However, if the ports are not able to adequately handle containers, either because the port has been destroyed by enemy actions or because it simply lacks the needed material or container handling equipment, congestion will occur. The military has not kept pace with commercial companies in terms of fixed port development. (17:42) The problem is compounded by the fact that military may deploy into any number of lesser developed countries which may not have adequate infrastructure or ports for larger vessels such as container ships. Container ships require cranes with capacities of between 140 and 300 tons. Only large, modern ports generally have this type of equipment. The military, although maintaining some capability, does not have enough ability with regard to container handling equipment or personnel required to perform major offloads of container ships. (17:31-32) LOTS has been suggested as a possible solution, but it is doubtful that it will meet the requirements of a major contingency by itself due to its slower container discharge rate, limited equipment, and a limited supporting infrastructure on shore. (17:33;14:103)

During the Vietnam War, limited deep draft ports and berths caused considerable congestion of ports. (15:4-32) At times, ships would wait half as long waiting for dock space as the

voyage from the United States. (40:46) Sometimes, dozens of ships were waiting outside the port to be off-loaded. The problem was so bad that several radical ideas were developed. One such idea was the MAPCAT system of transporting cargo to shore by using containers which were equipped with floatation devices. Much of the problem of port congestion could be summed up in terms of inadequate infrastructure. The same situation could exist today should the US need to conduct off-load operations at undeveloped or damaged ports. During Desert Storm, port operations were not nearly as congested as during Vietnam. The lessons of war had been learned to some degree from previous conflicts such as Vietnam. The military did not want to see the same kind of port congestion, so they tested the ports in Saudi Arabia early in the conflict to ensure the adequacy of infrastructure and ports prior to sending the rest of the breakbulk and containerized cargo. (41:70) The gains in productivity and efficiency during Desert Storm can likely be attributed to extremely well-developed ports in Saudi Arabia and to the fact that the ports were never attacked by Iraqi troops. (41:70-71;1:12-13) Although operations did go fairly well, we cannot count on such ideal conditions in the future.

Other problems include high tare weights of ISO containers. This is especially important when dealing with air cargo. For example, with the tare weight of an ISO container being about 4,200 pounds, 20% of a Boeing 747 aircraft cargo weight capacity is eaten up simply by the weight of the container itself. (26:4) The future may bring improvement in high strength metals which will allow significant reductions in container tare weights; but, until then, this problem will continue to compromise the effectiveness of containerized air cargo shipments. Finally, the steady decline of the Merchant Marine creates potential problems for future container shipments. (18:18-20) As of today, the military must rely almost entirely on commercial container ship companies, many of which are foreign flagged, to move their cargo. This creates the additional requirements of having to meet commercial standardization requirements to be compatible with these ships.

Conclusions and Recommendations

The entire history of containerization gives us insights as to how to handle the supply pipeline problem during any contingency. History suggests that containers were developed to improve efficiencies and better protect cargo. Additionally, containers improved the competitiveness of the shipping companies throughout the world. Commercial shippers are not going to return to a breakbulk system of moving freight. To the contrary, the benefits of the intermodal transportation and land bridges, as well as the ability to conduct logistics movements deep into any country, suggest that containers will increase in importance. Developments, such as flatracks, seasheds, and high-density containers, are also making it possible to handle nontraditional containerized freight in a container environment. The military's dependence on commercial shipping, rail, and motor freight, all of which endorse intermodal transportation concepts, dictates that the military must also endorse those concepts. Since the military must, in many cases, operate their logistics pipeline in wartime the same as peacetime, the future suggests that the military must develop adequate plans to handle containerized freight during a contingency. This includes procuring adequate levels of MHE/CHE, developing MHE/CHE companies, or having contingency plans in case developed ports are not available.

Several formal recommendations have been suggested as a result of the history and development of containers. For instance, should a shortfall of containers occur, the production of new containers may be required. However, the US, at this time, does not maintain any manufacturing capabilities for containers. Contingency plans should be developed to ensure containers can be procured in adequate number. (13:139)

Other recommendations include developing adequate policies concerning accountability, numbers and use of containers, nontransportation uses of containers, and use of commercial versus organic containers. As part of this requirement, a system must be developed for tracking ownership and location of DOD-owned containers. The DOD relies primarily on the commercial sector for acquiring adequate numbers of containers. However, a nucleus of DOD-owned containers is also needed. The correct number of DOD-owned containers must be identified and procured. In conjunction with this, the US military must develop the means to track commercial sector inventories of containers so DOD can respond to contingencies and changes in technology and standards. Furthermore, DOD needs to estimate the availability of host-nation and civil support for container handling throughput. The infrastructure required for container handling varies significantly from country to country. The level and type of infrastructure should be identified and contingency plans developed to support container handling within each of these countries. Shortfalls in container handling equipment must be identified and equipment procured to fill those shortfalls. (42:5-16)

The US military must also conduct exercises to assess the adequacy of the transportation system during wartime situations. LOTS should be exercised as part of these simulated wartime scenarios to assess and improve the capability of transfer, marshal, retrograde, and management of containers. (42:16-21)

The future will likely include containerization at unprecedented levels. We, in the military, must continue to look at the lessons learned from the various conflicts and from the examples set by commercial companies to meet the requirements of future contingencies. The recommendations listed in this paper, along with many others, deserve serious consideration. Containerization is extremely important to the US military, and future conflicts will likely be unsuccessful unless logistics support, to include containerized shipment of war materials and supplies, is conducted in an efficient and effective manner.

References

1. Ebertowski, James S. (Colonel, USA). *Container Management Within the Total Distribution System of The Desert Storm Model*, Carlisle Barracks PA, US Army War College, 27 April 1992 (AD-A251 303).
2. Holmes, Harry E. "Containerization," *National Defense Transportation Journal* 17 (March-April 1969), pp. 29-54.
3. Bing, Tom L. *Impact of Containerization on Strategic Planning*, Carlisle Barracks PA, US Army War College, 8 March 1971 (AD-772 618).
4. Cook, David Michael. *An Analysis of the Effects of Containerization on Military Sealift Capability*, MS Thesis, Naval Postgraduate School, Monterey CA, December 1978 (AD-B036 552).
5. Arnold, John T. "Containerization - Past, Present, and Future," *Logistics Spectrum* 14 (Fall 1980), pp. 31-34.
6. Walters, James Stephen, *Freight Containers in Inter-modal and Land Bridge Commerce*, MS Thesis, Naval Postgraduate School, Monterey CA, September 1980 (AD-A095 861).
7. Cardwell, G. "From Clippers to Container Ship," *National Defense Transportation Journal* 20 (January-February 1964), pp. 32-42.
8. Hazard, John L. *Transportation Management Economic Policy*, Cambridge MD, Cornell Maritime Press, Inc., 1977.

9. Losey, Melvin D. (Brigadier General, USA). "CONEX: A Decade of Service," *Military Review* 43 (September 1963), pp. 32-37.
10. Forgash, Morris. "Containerization: A Progress Report," *National Defense Transportation Journal* 20 (November-December 1963), pp. 33, 39-66.
11. Grossman, Larry. "Break in the Container Logjam?" *Military Forum* 5 (June 1989), pp. 18-19.
12. Army Belvoir Research Development and Engineering Center. *Container System Hardware Status Report 1991*, Fort Belvoir VA, 1991 (AD-A239 508).
13. Woodman, Donna H.; Coughlin, Joseph; and Wolfe, I. Michael. *Optimizing Wartime Materiel Delivery: An Overview of DOD Containerization*, Volume I: *Past Efforts and Current Issues*, Cambridge MA, US Department of Transportation Research and Special Programs Administration Transportation Systems Center, April 1989 (AD-A236 282).
14. Huston, James A. *The Sinews of War: Army Logistics 1775-1953*, Washington DC, US Government Printing Office, 1966.
15. American Power Jet Company. *Containerization Based on Lessons of the Vietnam Era*, Washington DC, Joint Logistics Review Board, January 1970 (AD-877 965).
16. Shearin, D. J., Sr. *Proof of Principle - Inter-modal Container/Hooklift Interface Kit (IMCON/HIK)*, Report Series ASI-88-16, Aberdeen MD, ASI Systems International, August 1988 (AD-A232 770).
17. Angel, Donald K. (Lieutenant Colonel, USMC); English, Edward B. (Lieutenant Colonel, USA); Renier, Robert R. (Lieutenant Colonel, USMC); and Yamachika, Roy T. (Lieutenant Colonel, USA). *Containerization - A Snapshot of the 1980's*, Fort McNair, Washington DC, Industrial College of the Armed Forces, April 1983 (AD-A137 964).
18. Sowers, Susan R. (Captain, USAF). *The Army's Use of Containerization For Unit Deployments*, MS Thesis, University of Washington, Seattle WA, 7 December 1991 (AD-A244 260).
19. The Joint Logistics Review Board. *Logistic Support in the Vietnam Era Monograph 7 Containerization*, Washington DC, Office of the Assistant Secretary of Defense, 15 December 1970 (AD-877 965).
20. Priber, Leonard A. "Containerized Cargo Movement," *Army Logistician* 16 (March-April 1984), pp. 31-33.
21. Army Logistics Center. *The Army in the Field Container System Study (AFCSS)*, Volume II, Appendix F: *Containerization*, Fort Lee VA, Army Logistics Center, September 1974 (AD-B001 115).
22. Fay, Keith. "Containerizing Inbound Traffic," *Logistics Spectrum* 20 (Spring 1986), pp. 29-32.
23. Bakke, Karl E. "Today's Inter-modal Disincentives," *Defense Transportation Journal* 34 (June 1978), pp. 6-14.
24. Talpas, Edward G. (Major, USA) and Osgood, Donald W. "Containerization Comes to Ammunition," *Army Logistician* 10 (May-June 1978), pp. 12-16.
25. Berg, Wayne (Captain, USAF). "Containerization Arrives: It's Called '463,'" *The MAC Forum* 1 (January 1992), pp. 36-38.
26. Mohr, Dave (Captain, USAF). *Air Cargo Containerization Study*, Gunter AFB AL, Air Force Logistics Management Center, December 1991 (AD-B160 837).
27. Casey, Maurice F. (Major General, USAF). "Containerization and Military Air Logistics," *Defense Transportation* 26 (May-June 1970), pp. 56-60.
28. Parr, M. E. "New Technology in Maritime Cargo Systems," *Defense Transportation Journal* 28 (July-August 1972), pp. 34-45.
29. Hall, Dan. "Balloons Tested for Containership Offload," *Translog* 7 (April 1976), pp. 1-4.
30. Riley, John E., Jr. *Containerization - Can We Live With It/Must We Live With It?*, Fort McNair, Washington DC, Industrial College of the Armed Forces, May 1987 (AD-B116 373).
31. Bergeron, Scott (Captain, USA). "Deployment of Containerships: Panacea or Paradox?" *Translog* 13 (February 1982), pp. 7-9.
32. Saunders, George D. "Transporting Ammunition in Containers," *Defense Transportation Journal* 43 (April 1987), pp. 12, 18-23.
33. Rice, Michael M. (Captain, USAF) and Welch, Dennis E. (Captain, aUSA). *The Potential of an 8 x 8 x 5 Ft. Inter-modal Container as a Unitization Medium For Routine Military Air Cargo*, MS Thesis, AFIT/SLGR/SR/23-75A, School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson Air Force Base OH, January 1975 (AD-A006 675).
34. Hughes, Joseph D. (Colonel, USA). "MAPCAP Military All Purpose Container and Transporter," *Military Review* 47 (March 1967), pp. 56-61.
35. Systems Associates Inc. *Containerization Evaluation Study*, Long Beach CA, Systems Associates Inc., 24 October 1972 (AD-B003 002).
36. Gorgas, S. M. *ISO Containerization of MUST*, Camp Lejeune NC, Naval Medical Field Research Laboratory, 7 March 1975 (AD-B003 546).
37. Buffone, Robert J. *Marine Corps Shelterized Expeditionary Food Service System, Marine Corps ISO (International Organization For Standardization) Galley and Sanitation Unit*, Report Series NATIC/TR -83/023, Army NATIC Research and Development Labs MA, July 1982 (AD-A129 312).
38. Bykofsky, Joseph. "CONEX A Milestone in Unitization," *National Defense Transportation Journal* 14 (May-June 1958), pp. 49-73.
39. Collins, Gerald W. "CONEX: Logistics Wonder-Worker in Vietnam," *National Defense Transportation Journal* 22 (May-June 1966), pp. 18-26.
40. Mayor, Jack A. "Military Containerization Impact on Worldwide Supply," *Defense Transportation Journal* 27 (May-June 1971), pp. 46-49.
41. "Sea-Land's Global Team Effort," *Defense Transportation Journal* 47 (June 1991), pp. 70-71.
42. Woodman, Donna H.; Coughlin, Joseph; and Wolfe, I. Michael. *Optimizing Wartime Materiel Delivery: An Overview of DOD Containerization*, Volume II: *Framework for Action to Address DOD Containerization Issues*, Cambridge MA, US Department of Transportation Research and Special Programs Administration Transportation Systems Center, April 1989 (AD-A236 283).
43. Cohen, R. H., and Stryker, F. *Resupply in Peace and War by C5 Airlift and Container Ship* 3, Arlington VA, Institute for Defense Analysis Systems Evaluation Division, May 1969.

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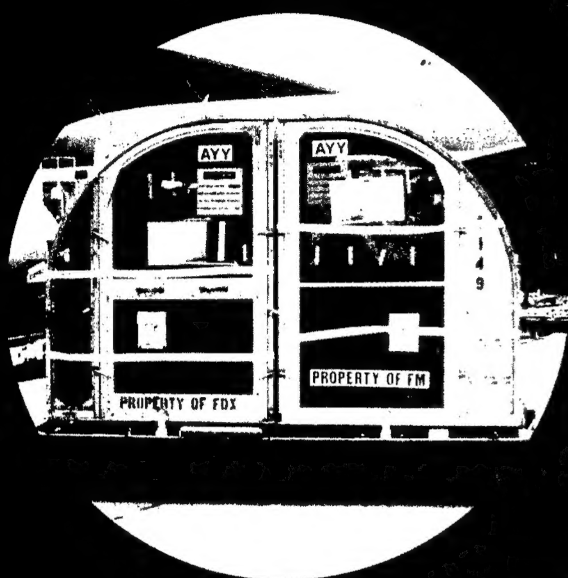
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